DISCOVERY

AUGUST
1947

1/6

DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

August, 1947 Vol. VIII. No. 8

Editor: WILLIAM E. DICK, B.Sc., F.L.S.
All Editorial communications to
244 HIGH HOLBORN, W.C.1. (Tel. Chancery 6518)
All Subscriptions, Distribution, Advertisements and Business communications to
THE EMPIRE PRESS, NORWICH, ENGLAND (Tel. Norwich 21441)

The Progress of Science

Secret Science and the Universities

THE pressing need for the education of more scientists, and the growing tendency towards scientific secrecy—these are two matters that necessarily occupy much attention today. When they combine in one problem, we naturally find an issue of some importance—so much so, in fact, that Sir Robert Robinson devoted a section of his recent presidential address to the Royal Society to it. His remarks being made in his usual brief and pointed style, we can quote them almost in full.

After referring to scientists' contribution to the war effort and the unfortunate continuation of something like wartime conditions for science in "an uneasy peace", he went on, "During the war the scientific effort was nation-wide and control extended to many university departments. Nevertheless the universities have preserved intact their precious liberty of action, and I see no signs of any attempt to curtail it. Surely this suggests a feasible line of demarcation in that extra-mural contracts, placed by Service Departments with the universities, need not and should not contain any irksome clauses restricting free publication of the results. Although it has sometimes been irksome, the refusal of many universities to accept theses that cannot be published is a step in the right direction."

This statement drew a letter from Dr. J. E. Keyston of the Department of Research Programmes and Planning at the Admiralty, which was published in *Nature*, together with a rather non-committal reply from Sir Robert Robinson. Dr. Keyston began with an assurance that the representatives of defence science are now "unanimous in deprecating any form of pressure on the universities to accept research contracts of the kind which seem likely to lead to unpublishable results." (We can join wholeheartedly in the welcome Sir Robert gave that assurance). Hence, said Dr. Keyston, the question of secret theses should not arise in connexion with 'internal' degrees—that is, degrees whose conditions require not merely the completion of a piece of scientific research, but also work in a university laboratory and/or residence in the university. But in the case of 'external' higher degrees, which are often taken by men on the basis of research they are carrying out in industry or a government department, there is something to be said for allowing secret theses. To refuse them puts the defence scientist at a disadvantage, for it will often completely deny him the possibility of a higher degree, and thus prejudice his chances of advancement—especially if he seeks work outside his department and is not in a position, for security reasons, to produce evidence of his past researches. Dr. Keyston concluded by suggesting that the Royal Society might offer to mediate on these questions between the universities and the defence departments—a suggestion of whose feasibility Sir Robert Robinson expressed doubts.

It would be presumptuous on our part to attempt a judgment of this issue. We shall be content with drawing further attention to it, and at the same time adding a few comments that may be helpful in any further discussion.

To begin with it is a curious fact that neither Sir Robert nor Dr. Keyston made any reference to the theses as contributions to the advancement of science as a whole. The thesis, in this sense, is a social matter, as well as one for the individual who submits it. And clearly the secret thesis can contribute nothing to society; for if the work involved in preparing it has contributed something to defence science, then that has been done irrespective of whether the thesis is written and accepted or not. The social, as opposed to the individual, value of any thesis lies entirely in its publication for use by others.

Again it should be realised that an M.Sc. or Ph.D. degree is usually more than a certificate that a worker has done a piece of research of a certain minimum value; it is also a guarantee that he has undergone a specified period of research training under fairly standard conditions —namely those of the university itself, or, in the case of an 'external' degree, those which the university approves. In using a degree to assess a man's suitability for a post, the latter aspect is often as important as the former. And in this connexion the 'external' degree cannot provide the guarantee; for those very circumstances which require secrecy for the thesis may well prevent the university authorities from satisfactorily verifying that the conditions of research training are adequate.

At the same time, the key to Sir Robert Robinson's

Denis Papin, inventor of the autoclave.

argument was that the acceptance of secret theses would have an ill effect on the universities as such. As Dr. Keyston justly suggests, he has not shown precisely what ill effects might be expected. One can see in a vague way that dangers of loss of academic freedom are involved. But until and unless the threat is demonstrated to be a serious one and adequate safeguards to be impossible, there is probably much to be said for the present compromise by which a few universities accept secret theses, while others insist that the theses be published or lodged in a library.

Papin, Pneumatic Pioneer

THERE can be few more ubiquitous pieces of apparatus today than the autoclave—an apparatus for confining boiling water or other materials and the steam they produce under high pressure, so that temperatures much above normal boiling-point are attained. It is a common piece of chemical apparatus; it is widely used for industrial purposes; in medical practice it is the commonest method of thorough sterilisation; and in the last few decades it has become well known to housewives as the pressure-cooker.

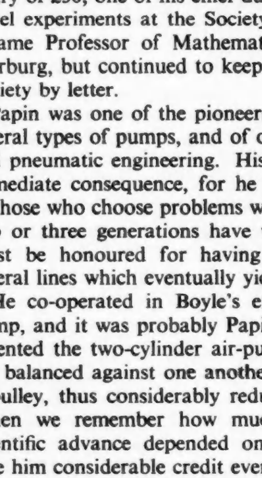
Cooking, in fact, was the chief use visualised by its inventor Denis Papin, the tercentenary of whose birth occurs this month. He invented it in 1681. John Evelyn in his diary has left a graphic description of a dinner cooked by it which he gave on April 12 of the following year to a company including several Fellows of the Royal Society. "This philosophical supper," say Evelyn, "caused much mirth amongst us and exceedingly pleased all the company." From his description the early pressure cooker seems to have been very successful. "The hardest bones of beef itself and mutton were made as soft as cheese, without water or other liquor, and with less than eight ounces of coal, producing an incredible quantity of gravy; and, for close of all, a jelly made of the bones of beef, the best for clearness and good relish, and the most delicious that I have ever seen or tasted."

For a long time Papin's 'digester', as it was called, was little used, though in the early nineteenth century, when a little knowledge of nutritional science had led to the dangerous conclusion that the poor could be sustained on gelatine alone, it had quite a vogue in charitable soup kitchens. But it is only quite recently that the digester has been used at all extensively for the purpose for which its inventor intended it.

Denis Papin was born at Blois in France on August 22, 1647. He was educated in medicine, but after graduating he worked in Paris as assistant to Huyghens, who turned his attention to physics, particularly to pneumatics. Being a Huguenot, he was in danger of persecution and so fled to England in 1675, where he found a welcome among men of science. He worked as assistant to Boyle, who introduced him to the Royal Society, of which he became a Fellow in 1680. A little later he was appointed Curator to the Society at an annual salary of £30, one of his chief duties being to demonstrate novel experiments at the Society's meetings. In 1687 he became Professor of Mathematics at the University of Marburg, but continued to keep in touch with the Royal Society by letter.

Papin was one of the pioneers of the steam engine, of several types of pumps, and of other aspects of hydraulic and pneumatic engineering. His work showed very little immediate consequence, for he seems to have been one of those who choose problems which do not bear fruit till two or three generations have worked on them, but he must be honoured for having taken the first step in several lines which eventually yielded heavy harvests.

He co-operated in Boyle's experiments with the air-pump, and it was probably Papin rather than Boyle who invented the two-cylinder air-pump in which the pistons are balanced against one another by a cord passing over a pulley, thus considerably reducing the effort required. When we remember how much of eighteenth-century scientific advance depended on the air-pump we must give him considerable credit even for this minor improvement. He invented in 1685 the first reciprocating compressor. In 1689 he made one of the earliest centrifugal pumps.



Papin's Steam Engine. A small quantity of water at the bottom of the cylinder *A* is heated to produce steam which pushes up piston *B* to the top. A latch *E* (manipulated by hand) engages in a notch in piston-rod *H* and holds it. On the removal of the fire, the steam condenses, *E* is disengaged, and atmospheric pressure drives the piston down, thus raising the weight attached to the rope *L* passing over the pulleys. The cylinder's diameter was 2½ inches. It raised 60 lb. a minute.

Just before he left England in 1687 he conceived the idea of the pneumatic transmission of power. Power was to be applied to a piston at one end of a long tube, and extracted by another piston at the other end. Needless to say, that was not a practical engineering project in the seventeenth century, but if the account of John Robison (an associate of Joseph Black and James Watt) is true, the idea played a key part in Newcomen's invention of the first really successful steam engine. According to this story, Newcomen thought of trying to put this vacuum transmission into practice and corresponded with Hooke on the subject; but Hooke dissuaded him and suggested that instead he should seek a way of making 'a speedy vacuum under your piston'—which is the germ of the atmospheric steam engine, in which the 'speedy vacuum' is created by the sudden condensation of steam in the cylinder.

As we have hinted, the story is not well authenticated; but if it does happen to be true, then it is a curious irony that this project should have had more effect on the development of the steam engine than all the very considerable labours which Papin directed specifically to that end. After attempting, like several others, to make a gunpowder engine, Papin turned his attention to steam, and by 1690 had succeeded in making the first rudimentary steam engine using a piston and cylinder. Rudimentary is certainly the word for it, because the cylinder acted also as boiler—the water lay in the bottom of a vertical cylinder, under which was the fire; the pressure of the steam drove the piston up to the top of its stroke; the fire was then removed (!) and the condensation of the steam produced a partial vacuum which pulled the piston down again. Not a very practical method, though with an improved design a few years later he did succeed in getting four strokes a minute, and he did get as far as to start installing engines for draining mines in Auvergne and Westphalia, though naturally without success. (Mine drainage was, of course, the chief incentive for the construction of early steam engines.)

Later, when the Savery engine was in use, Papin designed a modified form of it and then proceeded to apply this to make a steamboat. Others before him had proposed steam navigation, but Papin seems to have been the first actually to construct a steamboat which worked, however imperfectly, in 1707. Here he began to encounter, more violently than usual, that phenomenon which has since been christened 'the frustration of science'. He wished to bring his boat to London for a demonstration. First he found enormous difficulties in getting the permits which the feudal structure of Germany made necessary for moving the boat. Having at last started his journey, he came to Münden, where the boatmen of the Weser, thinking that if the invention were successful their occupation would be superseded, seized the boat and destroyed it. A year later Papin wrote to the Royal Society asking for a grant of £15 to build another model. His plea was rejected and shortly afterwards (the date is uncertain, but it was about 1714), worn out and disappointed, he died.

We have left to the last the one invention of Papin's which is universal in modern steam-engine practice—the safety valve. Here there is another irony, for Papin invented the device as a safety precaution for his digester, and he did not apply it to his own steam engine.

The German Atomic Bomb Project

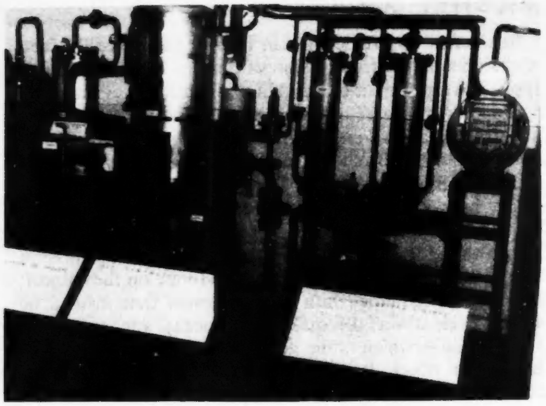
AT first sight it seems nothing short of astounding that the German atomic bomb project made so little headway. The key discovery, that of uranium fission, had been made in Berlin but it was the Allies, not Germany, who recognised its full potentialities and exploited it for military purposes. In those later stages in atomic bomb production where uranium 235 had to be separated on a vast scale or plutonium made in quantity, huge resources were needed both of men and material, and here the United States clearly held the whip hand over the Germans. But the Germans lagged behind in the race for an atomic bomb long before those stages were reached. This was because the Germans lacked the conviction that an atomic bomb was potentially a decisive weapon; having expelled so many top-flight scientists the directors of Nazi war effort lacked physicists of the highest calibre and never received the sound scientific advice that the British and American governments did. The effect was that those who drew up priorities for the different items in the Nazi war effort were never in a position to appreciate that the atomic bomb was of far greater importance than V weapons, with the result that from the beginning the German atomic bomb project received little official support.

These points emerge clearly from the chapter in a recent book by Dr. Hans Thirring entitled *Die Geschichte der Atombombe* and published in Vienna. He stresses that the decisive difference between the American and the German endeavours lay in the fact that in 1942 the Americans decided upon an all-out technical and industrial effort in favour of the atomic bomb project whereas the German government never decided on such action—and indeed from 1942 onwards was not in the position to put such a decision into effect had it taken it.

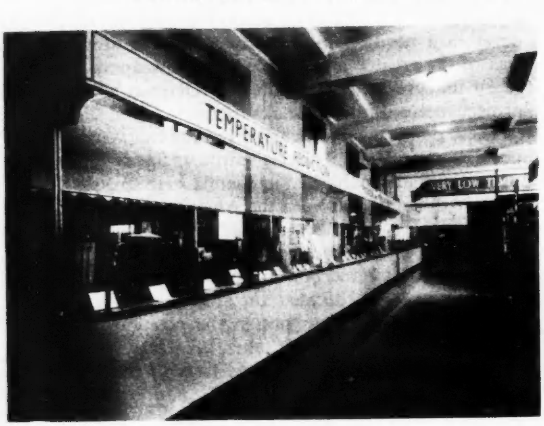
Dr. Thirring traces this failure back to the anti-Semitic policy of the Nazis. From 1933 nationalist 'German physics', of which Lenard and Stark were the most notorious exponents, gained more and more support, to the extent that important advances in theoretical physics could be dismissed as 'Jewish physics', in particular the theory of relativity and the quantum theory. Einstein's fundamental equation $E=mc^2$ was called a Jewish lie, and even in 1941 when the Germans had started their atomic bomb project one found advocates of the Lenard-Stark line describing the possibility of converting mass defects into energy, as being nothing more than a flight of imagination!

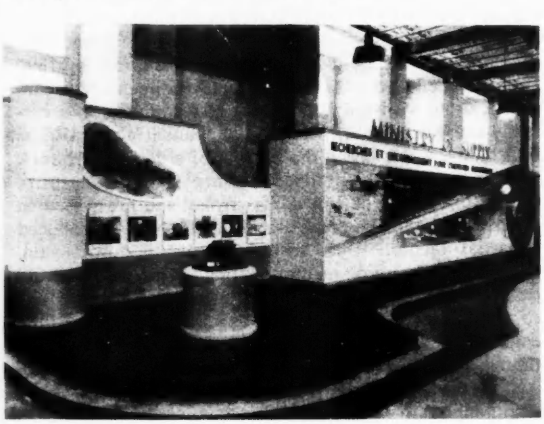
Some eminent physicists still remained in Germany, however; for instance, Planck, Laue, Hahn, and Heisenberg. Dr. Thirring takes the view that many of the best scientists remaining in Germany, in particular Hahn and Laue, were quite certain from the outset that it would be a crime against humanity to present Hitler with so dangerous a weapon as the atom bomb.

According to Dr. Thirring, the rather scratch team of atomic physicists who worked on the German atomic bomb project was known in scientific circles by the nickname of 'The Uranium Club'. Their researches were carried out partly in the laboratories of the Heereswaffenamt at Kamersdorf and Gatow near Berlin, partly in Planck's institute in Dahlem under the direction of Heisenberg. Investigations on problems relating to atomic



The Science Museum's special exhibitions are a powerful means of publicising scientific achievements. (*Left*) The penicillin exhibit in the Chemical Progress Exhibition is inspected by Sir Robert Robertson (*left*) and the Minister of Education at its opening last month. (*Right*) Another item in the Chemical Progress Exhibition, a pilot plant used by the Fuel Research Station for experiments with the Fischer-Tropsch process.





(*Left*) Before the war the Science Museum staged seventy special exhibitions, of which the Very Low Temperature Research exhibition was an outstanding example. (*Right*) Other Government agencies are making good use of the same medium. This photograph shows part of the Ministry of Supply's exhibit on aeronautical research displayed in Paris last year.

(*Left*) Excellent display technique characterised the Atomic Exhibition run by the *Daily Express*. (*Right*) This corner of the Chemical Research Exhibition, organised by I.C.I. vividly illustrated the development of polythene.

piles we
and Vie
paraffin
heavy w
For this
stepped
plant at
later the
view tha
German
the pile
carried o
places in
was the
uranium
manner
of U 235
an effecti
out in th

Museu

ONE of
trating th
the Che
Science I
Society a
Research
the cente
exhibitio
Septembe
The fi
advances
includes
of British
appeal to
fair numb
prepared
Research,
chemistry
bring hon
such field
Roads an
The exhib
much mo
survey of
century w
The exh
necessary,
exposition
special pa
putting fa
Most mus
against an
the spirit o
continuing
are indisp
science. I
be criticis
war it had
with the p
fine specia
organised

piles were made in Hamburg, Heidelberg, Leipzig, Munich and Vienna. In the first pile the attempt was made to use paraffin as the moderator; this was unsuccessful and heavy water was selected as the next moderator to try. For this reason heavy-water production in Norway was stepped up by the Germans. A commando raid on the plant at Rjukan cut off supplies of this vital material, and later the plant was bombed. But Dr. Thirring takes the view that even if there had been no interruption in the Germans' supply of heavy water their experiments with the pile would not have succeeded because they were carried out on too small a scale. "At none of the numerous places in Germany where the problem was being attacked was there sufficient pure metallic uranium to start a uranium pile and make the chain reaction work in the manner effected in America," he writes. The separation of U 235 was never carried out on any great scale, although an effective technique of gaseous diffusion had been worked out in the Berlin laboratories of Siemens and Halske.

Museums and Scientific Progress

One of the finest and most comprehensive displays illustrating the history of a particular science we have seen is the Chemical Progress Exhibition now running at the Science Museum in London. Organised by the Chemical Society and the Department of Scientific and Industrial Research, its opening last month was the first event in the centenary celebrations of the Chemical Society. This exhibition will remain open to the public until the end of September.

The first part of this exhibition illustrates the great advances that have taken place in chemical science and includes many of the most famous objects in the history of British chemistry. This section will make its greatest appeal to scientists, though it will certainly also attract a fair number of lay visitors. Of wider appeal is the section prepared by the Department of Scientific and Industrial Research, which vividly describes the contribution which chemistry makes to everyday life. This will very effectively bring home to the laymen the application of chemistry in such fields as Textiles, Agriculture, Homes and Buildings, Roads and Transport, Fuel and Power, Health and Food. The exhibition catalogue deserves special mention; it is much more than a list of exhibits, providing a handy survey of British chemical developments during the last century which is well worth a place on one's bookshelves.

The exhibition provides a reminder, if any reminder is necessary, of how powerful a medium for popular scientific exposition museums can be. It also demonstrates the special part that temporary exhibitions have to play in putting facts about science over to the general public. Most museums tend to be rather static, and this militates against an effective portrayal of science as a whole, for the spirit of science is indeed lacking unless the idea of its continuing progress is conveyed. Temporary exhibitions are indispensable to the museum presentation of living science. In this connexion the Science Museum cannot be criticised; it has an excellent record, and before the war it had already staged seventy special exhibitions dealing with the progress of science on particular fronts. Very fine special exhibitions on scientific themes have also been organised by the National Museum of Wales.

One wishes that everyone in the provinces could have the opportunity of seeing the special exhibitions arranged in the Science Museum. Many of these could be transported and put on show in provincial museums after their London run at a relatively low additional cost. We are not thinking here that the Chemical Progress exhibition could be circulated to the provinces, for this is on altogether too large a scale, though it might be possible to produce a special 'potted' version of the section dealing with "Chemistry in Everyday Life" for provincial distribution. Dr. H. Shaw, director of the Science Museum, recently gave some interesting figures regarding the cost of circulating such exhibitions and these suggest that a wider showing of temporary exhibitions is worth serious consideration. Before the war there was a Rubber Research Exhibition which went to Manchester and Edinburgh after a six-month run at South Kensington. The cost of the exhibition to the Rubber Growers' Association was £1850 (£1100 of which was accounted for in salaries) and the exhibition was seen by over 300,000 visitors while it was at the Science Museum. It was then packed in three railway containers and taken to Manchester where it was exhibited for two months and attracted 60,000 visitors. The cost of the Manchester exhibition was £850 (including £470 for salaries and £125 for transport). Finally it was taken to Edinburgh where it was on view for ten weeks and was visited by 58,000 people. Total cost in this case was £900 which included £600 for salaries and £120 for transport. The Rubber Research Exhibition incorporated a considerable number of demonstration exhibits which required the continual attendance of a staff of technical experts and demonstrators. Dr. Shaw estimates that most of the Science Museum's special exhibitions could be circulated to three or four different provincial towns at an annual cost of under £1000.

Colorado Beetle Bulletin

In Europe in 1947 no insect pest is taken more seriously than the Colorado Beetle. In the middle of the last century, this beetle became a pest in America, and moved across the United States in about 20 years, reaching the Atlantic Coast in 1874. As early as 1875 every European country was preparing legislation against it, yet whenever and wherever the battle has been joined, the beetle has, with one exception, succeeded in establishing itself as a more or less permanent pest. That exception is Great Britain, and for our own security we owe a real debt to the preparedness and determination of the often maligned Ministry of Agriculture.

Apart from a small outbreak at Tilbury in 1901, the story of the pest in this country dates from 1933, when a Ministry of Agriculture official found an adult Colorado Beetle at the same port. Even at that time, "preparations for dealing with a possible Colorado Beetle invasion had been made well in advance and an order under the destructive Insects and Pests Acts (dating from 1921) giving the Ministry the necessary powers, was awaiting signature". Actually over 2000 acres of potatoes were sprayed that year and 33 insects in all were discovered, which was a sufficiently large number to have formed the nucleus of a thriving colony had they remained undetected. Early in 1934, across the river at Gravesend, a few more insects

The Colorado Beetle and larva. (*Courtesy of Geigy Company*).

were found. Again the invaders were destroyed, and to make sure no stragglers survived "some 2,000 tons of soil were lifted, sieved over and examined handful by handful". During that summer only two beetles were found. In the autumn of 1935, immigration probably occurred from the Continent, as the following year provided widespread 'incidents' from several Eastern counties.

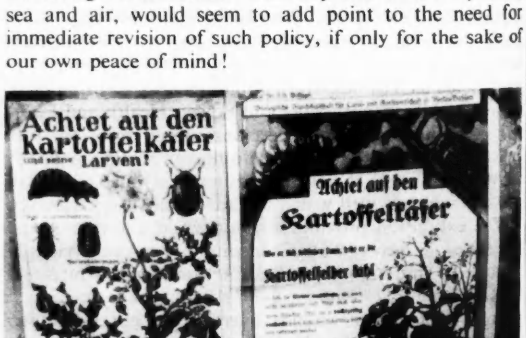
In 1938 the Ministry were again able definitely to state that the beetle was not established and this remained true until 1940. In that year numbers must have come over with our troops (the beetle having long been established in France and the Low Countries) as 1941 showed widespread and much larger outbreaks in fresh areas. These colonies had been exterminated by 1944, when a few more individuals reached us via returning invasion craft; to anyone who saw the extent of infestation in the invasion areas of France, that is hardly surprising. Since 1945, however, improved cross-channel communications and the complete conquest of the Pas de Calais by the beetle, have made frequent visitations inevitable. The discovery in 1946 of beetles near Croydon airport and at various ports-of-call of transatlantic vessels served to emphasise the increasing danger as world communications return to normal. Nonetheless, this year's reports seem to show that the 1946 attacks, much the most serious recorded in Britain, were successfully dealt with. This year, up to July 3, eleven small infestations of Colorado Beetle had been found and destroyed, and not more than two of these might have arisen from colonies undetected last year. The rest represent immigrants from various ship-borne sources. In addition 142 single beetles have been found.

Control methods used in this country consist of the close search of likely areas, followed by hand-picking, spraying with arsenicals, and soil-fumigation. To secure efficient searching of suspected areas, qualified university students have been put in charge of locally recruited gangs, a method which has proved very successful. (Troops were used for this purpose as long ago as 1877, during the first recorded European outbreak, in Germany.) That this treatment is expensive is obvious, but that the money is well spent no one can doubt. The account of the spread of the pest in Switzerland between 1937 and 1941, for example, shows how difficult it can be to deal with when once established in fresh territory. Despite intensive preparation over a period of twelve years, and as complete and efficient a system of pre-education of the public as any country could arrange, the Swiss authorities were unable to prevent the insect from spreading from 120 communes in 1937 to 2037 in 1941. This occurred in spite of the fact that the most up-to-date methods of exterminating the pest were applied, and regardless of cost.

A closer parallel to the British case is shown by Germany, where attacks were defeated in 1877, 1887, and 1914 before the insect finally became established. Yet even during the recent war period German scientists, in recording their failure to produce a plant permanently resistant to the beetle, "dismissed their lack of success lightly on the grounds that the damage done by the beetle in North Germany was slight and in any case could be effectively controlled by spraying", to quote a B.I.O.S. report.

At the same time, the Colorado beetle provides a case where one of the most effective methods of control lies in the hands of the Press. There is little doubt that good publicity given to the attacks of 1933 assisted the Ministry in their work, for their report states that "such help (of the public) is essential if the pest is to be prevented from effecting a permanent settlement in Great Britain".

But in every country, education of the public has always been regarded as essential in dealing with this pest and in this connexion the present situation in Germany may well give cause for alarm. There, posters against the 'Kartoffelkäfer'—'potato beetle'—which for years have been a familiar sight in urban as well as rural hoardings, are this year noticeably absent. This appears to be due to the unwillingness of the authorities to grant paper for printing the necessary posters. In a country where lack of chemicals for direct control combines with the poor physical state of a populace relying largely on potatoes for sustenance, such action seems less an economy than a serious act of neglect. The recent announcement of a large number of outbreaks in the Ruhr, coupled with ever-increasing travel between Germany and Britain by land, sea and air, would seem to add point to the need for immediate revision of such policy, if only for the sake of our own peace of mind!



Achtung Kartoffelkäfer! The German poster which is conspicuous by its absence from hoardings this year when damage from Colorado Beetle is liable to be most serious.

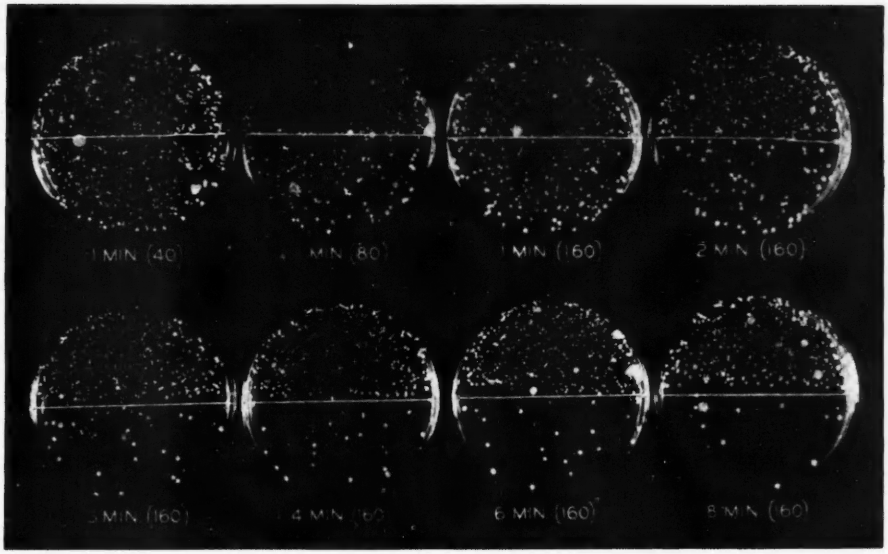


FIG. 1.—The nutrient culture medium in all six Petri dishes was exposed to airborne micro-organisms in a poultry house. The lower half of each was then exposed to ultra-violet light of varying intensity for varying times, and a large proportion of the organisms failed to survive this treatment.

Health and Ultra-violet

MAN'S natural environment is out-of-doors and an important factor in that environment is the radiant energy from the sun. This energy embraces a range of wavelengths from about 2900Å in the ultra-violet through the visible (3800–7000Å)* to the far infra-red and even to the shorter radio waves of a few centimetres wavelength. Besides providing light, some of these radiations have other important functions in relation to the human body which have only recently been studied scientifically, in spite of the fact that the therapeutic value of sunlight has been known for many years. As this knowledge has grown, it has been possible to develop 'lamps' of various types designed to provide radiant energy not of visible wavelengths but of those wavelengths which have been proved to be of value in the solar spectrum. In addition uses have been found for radiations of shorter wavelength than those which penetrate the earth's atmosphere. An interesting account of the technology and applications of these lamps has just appeared under the title *Applications of Germicidal, Erythemal and Infra-red Energy* (by Dr. M. Luckiesh; Van Nostrand, New York, 1947: Macmillan, London; pp. 463, 30s.).

Probably the most important radiations for animals are those concerned in the synthesis of Vitamin D, lack of which results in rickets. This vitamin, which regulates the deposition of calcium in the skeleton, was first found to be a constituent of certain fats in butter and cod liver oil. Some controversy arose at the time of its discovery because some workers considered that rickets was entirely dietary in origin while others demonstrated that it could be cured by fresh air and sunshine without altering the diet.

This conflict was resolved by the discovery by Prof. Steenbock that anti-rachitic properties could be conferred on a wide variety of foodstuffs by exposing them to ultra-violet radiation. It was later shown that when a substance known as ergosterol, which is a common constituent of plants and is also found in the fatty layers just beneath the human skin, was irradiated with ultra-violet of certain wavelengths, Vitamin D was formed. The product in this case (calciferol) is not identical with the active constituent of cod liver oil but the latter can be obtained by suitable treatment of the ergosterol before irradiation, and both substances are strongly anti-rachitic.

The wavelengths effective in Vitamin D synthesis are also those which produce the visible effects of erythema and sun-tan. Erythema is the reddening of the skin which develops within a few hours of exposure to direct sunlight. If severe over a large area of the skin erythema is dangerous as well as uncomfortable, and this limits the degree of exposure permissible for treatment of vitamin deficiency. However the amount of exposure necessary for adequate vitamin synthesis is very much less than that which causes severe erythema. The permanent tan which remains after the erythema has subsided is due to the deposition of pigment beneath the skin. The mechanism of both effects is not well understood, but it is known that tan can be produced by the longer ultra-violet wavelengths which penetrate the skin as well as by the shorter ones which are most effective in causing erythema. Sun-burn lotions should therefore contain materials which absorb the shorter wavelengths of sunlight but transmit the longer ones capable of producing tan.

The sun emits much radiation of wavelengths shorter than 2900Å but this is absorbed in the upper atmosphere by ozone and does not reach the earth's surface (Fig. 2). Were it not for this ozone life as we know it would not be possible for it has been found that radiation of wavelengths between 2000Å and 3000Å is lethal to plants and many micro-organisms, besides causing severe erythema. Such radiation is strongly germicidal (Fig. 1). The resistance of micro-organisms to it varies considerably, probably owing to differences in their cell walls, some of which may absorb the radiation before it reaches the protoplasm, but even so

* The Ångstrom unit (Å) is one hundredth of a millionth of a centimetre.

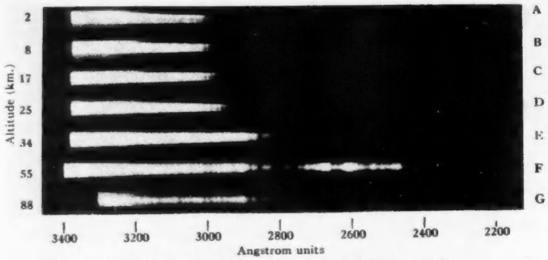


FIG. 2. Of these solar spectra obtained with a spectrograph mounted in the war-head of a V2 rocket, *F* shows the short-wave ultra-violet which is absorbed by the ozone at heights up to 34 kilometres. The ozone, itself produced by the action of still shorter wavelengths, is concentrated as a fairly narrow layer 30–40 kilometres above the earth.

comparatively small amounts of this germicidal energy are sufficient to reduce to a safe level the number of organisms in occupied houses, for example.

Infra-red radiation of wavelengths between 7000Å and 16,000Å is also of value to human health. This radiation is not absorbed by the skin but penetrates deeply into the underlying tissues, which it warms fairly uniformly, serving to stimulate the circulation. The effect of exposure to this radiation is similar to that of a Turkish bath, but it is achieved with much greater comfort and efficiency. Similar effects can also be achieved by electrical means (diathermy, etc.)

Sources are now available which, when power cuts are no longer an everyday possibility, would permit economic lighting installations to include special lamps for providing those beneficial radiations which are present in natural daylight but lacking in artificial light. In addition efficient sources of germicidal energy allow the same precautions to be taken against airborne infections in public buildings as are normal in other fields of public hygiene and sanitation. It must be said, however, that this field has suffered considerable exploitation at the hands of quacks and charlatans. Many devices claiming to fulfil such needs are still on the market which are quite useless.

Germicidal lamps are low-pressure mercury-vapour discharge lamps with special glass or quartz envelopes which are transparent to the 2537Å radiation produced by the discharge. For disinfecting occupied rooms they may be either installed in the ducts of an air-conditioning plant or arranged so as to irradiate the upper parts of the air. Direct exposure of the occupants to the rays has to be avoided because they can affect the eyes, but in normally ventilated rooms this is not necessary for good disinfection. These lamps have also many special applications in hospitals and food factories, and in the treatment of certain skin infections.

Wavelength (in Angstrom units)		*Effect*
Ultra-violet	2300–2800 Å	Germicidical (2540 Å most effective): these rays also produce erythema.
	2700–3100 Å	Vitamin D synthesis
	2900–3100 Å	Erythema (2970 Å most effective)
	2900–3500 Å	'Sun tan' effect
	3800–7000 Å	These are the visible radiations upon which photosynthesis by plants depends
Infra-red	7000–16000 Å	This radiation is transmitted by the skin and is capable of heating the flesh in depth.

TABLE I.—This table summarises some of the main biological effects of radiant energy. The effects do not cease abruptly at the limits of the ranges quoted, but gradually become less pronounced outside these limits.

Research in a Technical College

THE note which appeared in "Progress of Science" in June on the subject of research in technical colleges has brought us some detailed information about Huddersfield Technical College, whose Colour Chemistry Department has a remarkable record in the research field.

Huddersfield being an important centre of the dyestuffs industry, the local authority decided to establish a research department in Colour Chemistry in 1916. From 1918 onwards direction of the department has been in the hands of Dr. H. H. Hodgson. The connexion between that department and local firms has always been very close, the chemists of the technical college investigating problems relevant to the industry and the dyestuffs industry giving its support to the department by supplying chemicals and providing similar services, and also by endowing research scholarships. Towards the new research laboratories opened in 1940—these can accommodate some twenty research workers—the industry made a substantial contribution. Most of the research is done by full-time postgraduate students, but there have usually been a number of part-time workers, employed by local firms, who have carried out research studies in the evening.

Some measure of the Department's contribution to the advance of both theoretical and practical organic chemistry is given by the numbers of papers published in the leading chemical journals: for instance, over 200 papers have appeared in the *Journal of the Chemical Society*, and over 40 in the *Journal of the Society of Dyers and Colourists*. Research done in the Department has led to the award of nineteen Ph.D.'s by London University and four M.Sc.'s.

The two other main industries of Huddersfield are engineering and the production of high-quality textiles, and in both fields local industry has benefited from research done in the college. Research has also been done in physics, metallurgy and engineering, often in direct liaison with local industry.

The Englishman Looks at his Food

F. LE GROS CLARK, M.A.

Of the British diet of today some say one thing and some say another; but what shall *we* say of it, who at least make an effort to be scientifically precise? I think there is no real evidence of a general shortage of calories, because there is no real evidence of hunger. Hunger in the normal man is the warning, less of an immediate need for calories than of an approaching need; it is mainly a matter of gastric sensations, and it may precede by several hours a failure in his power of putting out energy. It is true that in a starving man the sensation of hunger may mercifully diminish; but we have scarcely passed through that experience. Moreover, the various estimates that have been recently made, though they can never be quite conclusive, suggest that our average calorie intake for all ages lies somewhere between 2,500 and 2,800 calories a day; and that would leave us far from exhaustion unless we were most of us (as we are not) engaged daily in moderately heavy manual work.

The Fat and Meat Habit

The relative scarcity of fats in the diet may have some influence on a community that has been accustomed to a fairly high fat consumption. Fat, of course, provides, weight for weight, double the calories of starch; and an organism that has been used to obtain 25–30% of its calories from fat may not readily adapt itself to the more bulky starch diet with which the fat would have to be replaced. But surely after seven years of fat rationing our digestive tracts have made some effort at adaptation, especially when we have had the stimulus of war to encourage them in the attempt. Subjectively more important is perhaps the fact that a low fat diet passes more rapidly out of the stomach and induces the fairly common remark that it "doesn't stay with you". The food of many peoples in the world is mainly starch; and it never does "stay with them" for long. But they are presumably used to that; the folk memory of a diet that gave two or three hours of a feeling of repletion may, however, survive in a community.

Even more significant, for those who have been accustomed to them, may be the inherently stimulating or dynamic properties of certain foods such as meat. It is probable that their nature has not been fully appreciated. Without being in any sense drugs, they provide an organic *kick* that can actually replace the impulse that should more properly come from a man's subjective interest in his work and from his enduring and unquestioned will to survive. I have no evidence for the theory; but I suggest that the stimulus derived from certain foods such as meat can so far replace by long tradition the more profound stimulus provided by an active endocrine system, that it becomes for a while exceedingly difficult for a community to recover its own physiological balance. Meat, too, has been for many generations a much valued food in this country; and we are possibly more inclined to consider it the ultimate source of our vigour than is any other nation in the world. The 'roast beef' style of patriotism has not been without its influence upon our way of life. Only through a sudden and radical excitation of our moral energies can we recover the organic balance that we have tended to lose by the relative inaction in us of some emotional system or some glandular complex.

The Margins of Deficiency

Speculations of this nature may be of use, if they lead us to a more careful inquiry into a very obscure problem. Science is as yet only moving about the fringes of the problem of food and the part it plays in the human mind. But that all this will have little effect on those eccentric medical men, who persist in saying that we are on the verge of *starvation*, we may be quite sure.

Let us, however, attempt a closer and more intimate description of the British diet; for we do know that there is something amiss in it or, at all events, in the impression it makes upon us.

Now, beyond what I have already said on the matter, there are two or three comments to make. First, a number of us have probably been suffering over the past few months from slight deficiency in Vitamins A and C. The supply of winter vegetables has been poor; and this is in any case one of the weaker joints in our nutritional armour. But I greatly doubt whether more than a few of us have been near gross deficiency, since the basic requirements of these two vitamins have probably been much exaggerated. We could always absorb more of them with advantage; but we can get through on relatively little. The intake of animal protein (viewed simply as protein) should in most instances be adequate; But this, as I have said, will not necessarily convince us that we are a well nourished people.

There is believed to be a common feeling of fatigue in the country; and there are certain dispersed minor complaints, the precise origin of which may be obscure to the practitioner. We are dealing here, of course, with a region where the dietetic and the psycho-somatic factors interbreed in a most confusing way. What we blame for a feeling of *malaise* may be quite remote from the true cause. An Indian coolie suffering from incipient beriberi may, as far as I am aware, ascribe his sensations to blue devils; but a man in Manchester or Glasgow, who is merely 'fed up' with the course of events, may as readily imagine that his lassitude is due to a poor diet. Yet there may often be other factors at work in the onset of beriberi beyond the purely dietetic one; and a beef steak and a pint of bitter might temporarily work wonders on our own moods of depression. All we can safely say is that where men throughout history have had a task worth doing (as far as their judgment carried them), they have frequently forgotten to be tired or ill even on a fairly poor and monotonous diet. There are, of course, physiological limits to what the body will endure by way of deprivation; but we are far from these limits.

There is no precise or objective evidence of it. A more accurate definition of our diet and its insufficiency is to

say that it suffers from being traditionally composed of *too many unconnected items*, most of which happen to be in short supply. It has been described as a "diet of shreds and patches". Now, the normal human being prefers to have a plenitude of at least one or two items in his diet; they seem to provide him with that spiritual sense of the overflowing granary, for which his soul apparently craves. The present pattern of our diet is very hard on the scientific administrator, who has constantly to maintain a precarious balance between a large number of foods in short supply; and it is hard on the housewife, who can rarely be open-handed with her family or her friends. Yet this diversified type of diet, in which many items are given some measure of value by the consumer, is really a matter of recent development in human history, at all events as far as the masses are concerned. Most peasant communities (and that is still the basic habit of life of at least 75% of mankind) tend to adopt a simple dish, upon which they build the day's fare. In the East it is for many millions the bowl of rice, to which may be added such fragments of meat, fish, beans and so forth as become available.

Elsewhere it is ordinarily a stew or soup with a foundation of meal, potatoes, beans, cabbage and the like; to this in Europe is added the portion of bread, of which two pounds or more may be eaten dry in the course of a day. I do not suggest that the average Yugoslav or Pole gets no more than this. What I mean is that this kind of diet is the basis of his *ménage*, whereas we on the other hand have over the last two centuries acquired a more complex pattern of diet, which probably originated with the urban middle-class of the late eighteenth century and spread gradually through the whole population. In one way, the simpler the dietetic formula, the more adaptable it is to changing conditions, *provided only* that the basic ingredient is available in the form of rice, potatoes, meal and bread. Our Ministry of Food, however, showed sound judgment when it decided early in the war to maintain some semblance of the varied British diet of pre-war days. The real question is, Where do we go from here?

We have always assumed that at some time we should revert to the kind of diet we preferred, or believe we preferred, before the war. There might be slight modifications; probably we should, for instance, consume more milk per head and maybe we should eat more vegetables. The war has not been without its beneficial effect upon our habits. But in the main the pattern of diet among the better-off industrial workers is sufficiently universal, allowing for local variations in taste; and this is the diet that nine-tenths of our families would adopt where their incomes gave them the chance. It is the diet of a people that has for some generations been accustomed to fairly cheap supplies of coal and to large supplies of imported meat, fats, sugar, spices, dried fruits and varied cereals.

Increase in Total Demand

Now, as everyone knows, these and other foods are in short supply and likely to remain so for an unpredictable period of time. The trouble is that we shall need considerably larger total supplies of these foods than we acquired before the war, if by 1950 or so we are to dispense with restrictive controls and permit the consumer to buy as his tastes incline him. Let us examine a few of the relevant figures.

I am going to take the mid 'thirties and compare them with the position today. Our population has increased; it is now over 48,000,000 as compared with 45,500,000 in 1935. That is a rise of about 5%. Then, we have today a larger proportion of adults in the country; and this would imply some increase in consumption per head, if every consumer could obtain all the foods he fancied. The rise in the proportion of adults is not large as yet, but it will increase considerably as the 'fifties pass over us. Finally, the country is committed to a policy of high employment and tolerably high wage levels. In other words—*if the price of food is held constant*—the *average* family will be demanding more of the varied and more attractive foods than it did in 1935.

We may let surmise have free play; no precise figures can be adduced. But when Sir John Orr in the mid 'thirties estimated the levels of food consumption, he showed them for various income levels and for the weighted national average of all these levels. It is permissible to suppose that a general rise in working-class incomes would mean that the average diet level would move upwards from Orr's weighted national average to his fourth consumption group, which represents families with a weekly income of between 20*s*. and 30*s*. per head. On that assumption, and allowing for the increase of population, how much more *total* meat, sugar, fats and so forth should we theoretically need today (if only we could obtain them) than we actually secured from all sources, home and overseas, in 1935 or thereabouts?

The increase would be considerable; and the following tables give some idea of its magnitude. I am assuming that consumption levels would have settled down to a normal demand and that probably many of the higher income groups would be consuming rather less of some of the foods than they did in the 'thirties.

Needless to say, our total consumption of these foods at present is considerably below the total pre-war consumption; and thus the increase in supplies that would have to take place, if the potential demand is to be fully satisfied, is of a far higher order. The next table compares our total consumption in 1944 with what it would have to be today, on the assumption that every family could acquire as much as its purchasing power would permit.

We have clearly some way to go before the existing potential demand, reckoned on the basis of the average purchasing power and the increased population of the country, could be satisfied. Can we secure all this additional food, and from what sources? If we cannot secure it, what prospect have we of an escape from continued rationing, allowing that fair distribution is to be maintained? Finally, if the prospect is remote, how will the public react as it dawns upon them that they are destined to live indefinitely upon this diet of "shreds and patches"?

I have assumed the continuance of food subsidies, as a means of holding the price of food more or less constant. Of course, if the subsidies are permitted to lapse, even partially, the situation would entirely change.

But the use of subsidies has become almost an accepted feature of our economy; and whatever may be said against them, there is little question that their removal would plunge the country into labour disturbances that would ultimately cost us far more than we are already paying.

TABLE I

COMPARISON OF THE TOTAL CONSUMPTION IN TONS IN 1935 WITH THE POTENTIAL CONSUMPTION TODAY

Food	Total consumption annual average 1934-38	Possible present consumption allowing for present wage levels	Possible present consumption adjusted for population increase	Approximate percentage rise from pre-war consumption
Sugar	2,184,000	2,312,000	2,428,000	11%
Meat (including bacon)	2,707,000	2,932,500	3,079,000	14%
Fats	905,000	950,000	998,000	10%
Fruit (including tomatoes)	2,406,000	2,526,000	2,653,000	10%

Nutritionally the subsidies are justified, even though in the long run we shall have to attack them by a systematic effort to lower the costs of production and distribution. For what do they imply? They are costing the taxpayer between £300 million and £400 million a year; their tendency has been to rise. But in 1945–6, for example, the duty on tobacco yielded £416 million and the duties on beer and spirits together £324 million. What has really happened is that we have been taxing the luxuries of some consumers in order to provide all consumers with cheap necessities in the form of their daily food; it is a legitimate enough method of national housekeeping. As I say, the dietetic argument appears overwhelming, since we have at least managed to maintain the semblance of a balanced diet for the whole community.

The Changing World Market

But is it more than a semblance? I have concluded that much of the prevailing sense of insufficiency is subjective; but that does not make it less real. How then shall we escape from it? For let us be under no illusion. Apart from the problem of our large food imports and of the dollar exchange, there are signs that the pattern of world food markets is gradually shifting from its pre-war form, in which the British import market was a dominating factor. We shall not necessarily be able to secure our supplies from all the sources that were open to us in the 'thirties. Shall we, for instance, re-establish our markets for vegetable oils, rice, and fruit, in the Far East, or will these countries develop their own consumption and begin to trade among themselves? How far will the industrialisation of Latin America mean that this region increasingly absorbs its own agricultural products? To what extent will the products of the Scandinavian countries begin to move into the markets of Eastern Europe? Problems of this nature impose upon us the need of developing a *long-term* food policy; we may otherwise emerge from the period of world shortages only to find that we can no longer deal in a cheap world market or even that there are areas no longer willing to release their products freely into world trade.

Moreover, the age of cheap food may have departed for ever, at all events until the costs of production and distribution are lowered by the increasing use of mechanical equipment and the higher organisation of labour.

There is only one solution. We must have a *long-term* food plan, conceived on the grand scale. A plan will not yield immediate results; but it is the only antidote to the slow loss of spirit that is beginning to affect too many of our people. Maybe we never shall return to our pre-war pattern of food in its entirety. In that case, we shall have to adapt ourselves to a new dietetic pattern, that can at least promise us a plenitude of certain of the basic foods.

TABLE II

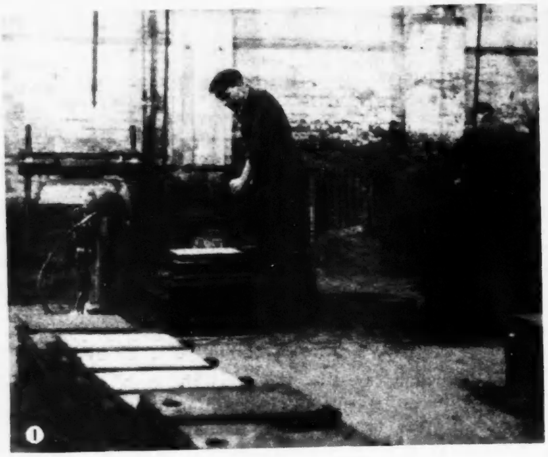
COMPARISON OF THE TOTAL RATIONED CONSUMPTION IN TONS WITH THE POTENTIAL CONSUMPTION TODAY

Food	Total consumption 1944	Potential present consumption	Approximate percentage rise required
Sugar	1,641,000	2,428,000	48%
Meat (including bacon)	2,577,000	3,079,000	19%
Fats	819,000	998,000	22%
Fruit (including tomatoes)	1,324,000	2,653,000	100%

There is here no space to discuss such a plan in detail. It would have to depend upon a combination of an increase in home production and the development of fresh sources overseas. At home we shall certainly have to produce far larger supplies of high-grade feeding-stuffs; and here a beginning has already been made with the proposal for co-operative grass-drying schemes and the experiments with the cultivation of oil-bearing plants. We shall further, in my view, have to become one of the milk-producing countries of the world to a far larger extent than we are at present. This will imply the breeding for milk herds rather than for prime beef, the expansion of ley farming, the reform of dairying practices towards the most efficient size of herds, and the use of excess milk above the fluid demand for cheese-making and drying. If in the process we can become a convinced milk—and cheese—consuming country, like some of our neighbours on the Continent, we shall effectively solve our main problem of the supply of animal protein foods.

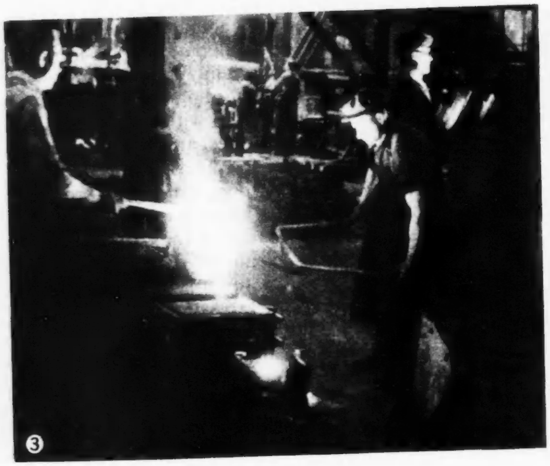
The rest lies with the development of new sources overseas; and here, in brief, we shall have to turn mainly to Africa. It will all depend upon our ability to raise the educational and health level of the African native and to release his powers of self-organisation. There is no question, either that the production can be achieved at the present level of African culture or that the native is prepared to produce a surplus for export unless he gains some of his elementary needs. But if we realise this we can in time attain the surplus production we require, not only in vegetable oils but in sugar, tropical fruits and, above all, in feed grain for our live-stock. The African continent offers a vast problem in scientific agriculture; but we are or should by this time have become scientific agronomists.

As for meat, bacon, butter and some other traditional foods, I have the impression that they may continue to be in short supply for many years to come. In that I may be wrong. But so probable is it, that we were well advised not to wait. It is preferable to have an unlimited supply of margarine than a parsimonious ration of butter. It is preferable to work hard at fresh sources of production than wait like pensioners for the dollar market to shift in our favour and for the world to consent again to feed us in the way to which we had grown accustomed in the past.

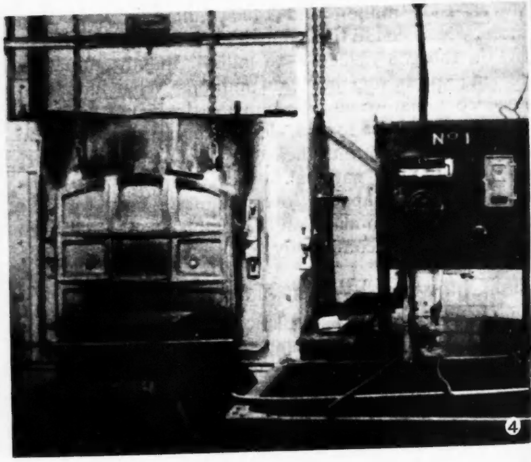


1

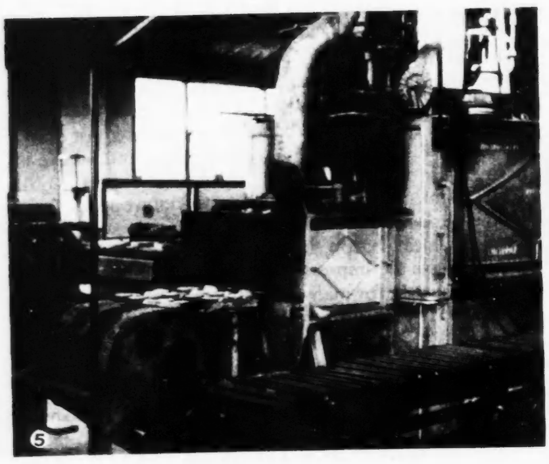
2



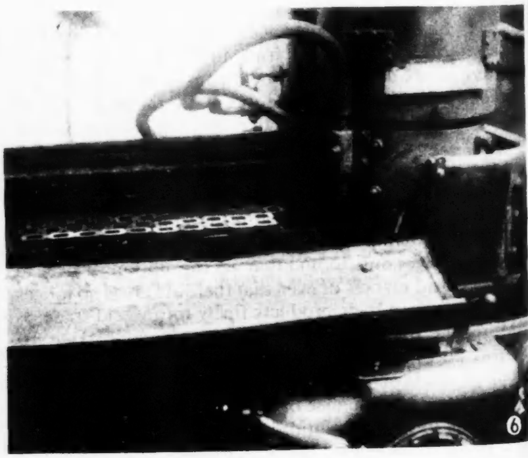
3



4



5



6

DURI
impro
magn
magn
Consi
durin
used
thems
An
given
and
mode
proce
comp
Pra
repel
very
The l
sligh
mate
arrar
point
ferro
magn
field
magn
Th
gado
arrar
magn
not c
'dom
the s
diffe
abou
A c
direc
the c
ponc
what
magn
As
conta
which
used
more
Th
hard
obta
factu

FIG.
frequ
the n
a sho
by ar
FIG.
them

Modern Magnets

MALCOLM McCAIG, Ph.D., F.Inst.P.

DURING the last two decades there have been great improvements in permanent magnets. Much stronger magnets can now be made, and in consequence permanent magnets can now frequently replace electromagnets. Considerable use was made of these improved magnets during the war as they were required for the magnetron used in radar, and also for limpet mines which attached themselves to the steel sides of a ship by means of magnets.

Another aspect of these advances is that a magnet of a given strength can now be made with a much smaller size and weight than hitherto. The production of the best modern magnets involves some very interesting and novel processes, requiring a very precise control of chemical composition, and of temperature.

Practically all materials are very slightly attracted or repelled by a magnet, although delicate apparatus and a very strong magnet is needed to demonstrate this fact. The largest class of materials known as *paramagnetic* are slightly attracted. It is believed that each atom of such a material acts like a little magnet. These atomic magnets are arranged in a random manner. If they could be made to point all in one direction the material would become *ferromagnetic*, i.e. it would be attracted as strongly to a magnet as a piece of iron, but even the strongest magnetic field we can produce is insufficient to align these atomic magnets to more than a small extent.

There exist four elements—iron, nickel, cobalt and gadolinium—in which, owing to some peculiarity of the arrangement of the electrons in the atoms, the atomic magnets are already fully aligned. This alignment does not extend throughout the material, which is divided into 'domains'. Within a domain all the atomic magnets point in the same direction, but in different domains they point in different directions. The size of a large domain is just about big enough to be seen with a powerful microscope. A comparatively weak field is sufficient to reverse the direction of magnetism of a domain, so that even if all the domains are not completely aligned there is a preponderance of those pointing in one direction. This is what happens to a piece of iron when it is attracted by a magnet.

As a matter of interest it may be mentioned that alloys containing no ferromagnetic element have been found which have ferromagnetic properties, but all the alloys used commercially for permanent magnets contain one or more of the metals iron, nickel or cobalt.

The first permanent magnets were simply made of a hard carbon steel, and the first special magnet alloys were obtained by adding tungsten or chromium. The manufacture of magnets of tungsten and chromium steel differs little from that of any steel article. Usually the material is rolled while hot into some conveniently shaped strip or rod. This strip or rod can be pressed or bent into shape while hot, or sawn, drilled, or turned on a lathe while cold. When a magnet of the required shape has been produced it is hardened by heating to 850° C. and quenching in oil or water. The magnet is now ready to be magnetised, a process which is often left to the purchaser, since it is easier to pack magnets in the unmagnetised state.

The next step forward was the introduction of cobalt steel magnets. The more cobalt that is used up to 35% the stronger, but the more expensive, the magnet. Cobalt is a relatively expensive metal and its introduction also makes the material harder to work.

An entirely new departure in the manufacture of magnets was discovered in Japan about 1930. The new alloy consisted of iron, nickel and aluminium. Magnets containing these metals are now made in this country under the name of Alni, or if cobalt is also added as Alnico. These alloys require a new kind of heat treatment which includes keeping the magnet at a temperature of about 600 C. for a considerable time. The exact temperature and time depend on the precise composition. This treatment hardens the alloy both mechanically and magnetically, i.e. gives it a high coercive force. Most of these alloys are so hard that it is almost impossible to forge, cut or drill them even before they have received this heat treatment, and the usual method of manufacture is to cast the magnets as nearly as possible to shape and remove any rough parts, or reduce to exact dimensions by grinding. A modern magnet factory contains an amazing range of grinding machines of different shapes, including internal grinders for grinding inside holes and gaps. When, however, small holes are required in a magnet as, for instance, for fixing screws, the usual practice is to cast with a larger hole which can then be filled with a soft alloy capable of being drilled.

Until just before the last war various ranges of Alnico were the best magnet alloys known. In 1938 Oliver in England discovered that it was possible to make an anisotropic magnet; that is, one more easily magnetised in certain directions than others. This is done by heating the magnet to a high temperature and allowing it to cool in a magnetic field. Both the initial temperature and rate of cooling must be carefully controlled if the best results are to be obtained. The field must be applied in the direction in which it is ultimately intended to magnetise the material. The treatment enables considerably more powerful magnets to be made, the advantage being gained at the expense of the ability to magnetise the material in a direction at

FIG. 1.—Machine making sand moulds in which magnets are cast. FIG. 2.—The alloy is melted in a high-frequency electric furnace, from which it is seen being poured. FIG. 3.—The actual operation of casting; the molten alloy is poured by hand into the sand moulds. Afterwards the castings are cleaned of sand by a shot-blasting machine; they are then heated to white heat and allowed to cool in a magnetic field produced by an electromagnet. FIG. 4.—Annealing in an electric oven, whose temperature is automatically controlled. FIG. 5.—When the time of annealing is not too long, large numbers of magnets may be treated by passing them through an oven on a slow-moving conveyor belt. FIG. 6.—Surface-grinding a large number of magnets, which are held by a magnetic chuck.

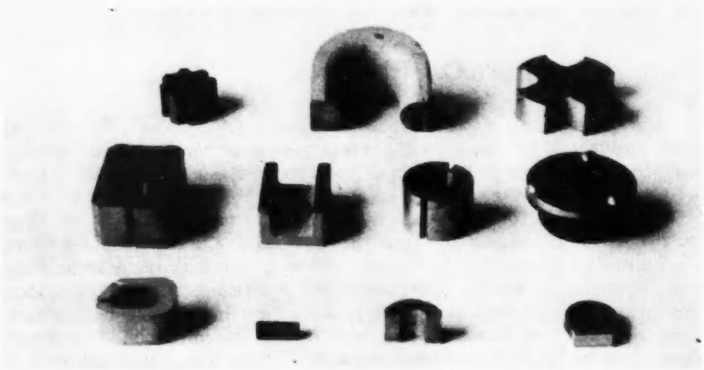


FIG. 7.—Permanent magnets and their applications.

Left to right:

Top row—Magnets for cycle dynamo, small magnetron, four pole magneto.

Middle row—Electric instrument (ammeter or voltmeter), ribbon microphone, small D.C. motor, loud-speaker.

Bottom row—Electricity meter, water heater thermostat, gramophone pick-up, small general purpose horse-shoe magnet.

right-angles to that in which the field is applied. Since the processes of manufacture are lengthy and expensive, it is good practice to make and test a few magnets from each cast before any time is wasted on the remainder. Various stages in the manufacture of magnets are illustrated in Figs. 1 to 6.

Since the alloys with the best properties are more expensive to produce, it does not follow that the latest alloy is the most economical to use in all cases. When a strong magnet is required, this can be made of much smaller size if one of the latest alloys is used, and in consequence the best alloy will probably also be the cheapest. For some purposes the magnet cannot be reduced in size because of the nature of the apparatus in which it is installed. For such a purpose it would probably be unnecessarily extravagant to use one of the more expensive alloys. One can in fact find the whole range of alloys from, say, tungsten steel to Alcomax being used in the same factory to make magnets for different purposes. It is in fact possible to calculate the most economical alloy to use for any given specification.

Fig. 7 gives some idea of the wide range of purposes for which permanent magnets are now used. The range of magnets shown in Fig. 7 is by no means exhaustive. Magnets are also used in telephones, and electric clocks, and may possibly be incorporated in television receivers. For each purpose there are usually many different designs of magnet for different types of instrument, or for the use of different manufacturers. This wide range of design has hindered the introduction of mass production methods into magnet manufacture.

In considering whether a permanent magnet can replace an electromagnet, the ability to switch off an electromagnet is obviously an important consideration. Anyone who has used a strong magnet to remove some iron filings from a mixture and has then tried to separate the iron filings from the magnet will appreciate this point. This difficulty can now be overcome, and it is possible to construct a permanent magnet without any electrical wiring which can 'switch off'. This principle is very useful for separator magnets, and also for magnetic chucks. (Electro-magnetic chucks have long been used for holding work on lathes and, more especially, for grinding processes. They are particularly used in the manufacture of magnets themselves.)

The nature of magnetic materials is such that there must be some ultimate limit to the extent to which permanent magnets can be improved. This theoretical limit has not been reached by any means. How near future research will enable it to be approached in practice remains to be seen, but there is a good hope that further considerable improvements will be made. There is also room for research to simplify and cheapen the manufacture of magnets with existing properties.

For some purposes it is an advantage to make magnets by a process of sintering. In this process powders of the various ingredients of the alloy are mixed together and compressed into the required shape. The compressed article is then heated to a temperature sufficient to cause the various components to fuse together, without causing the object to melt completely and lose its shape. The sintered magnets are slightly less dense than the cast ones, but for a given mass their magnetic properties are about the same. The process of sintering is generally used for rather small magnets.

A large number of other materials for permanent magnets have been devised, but have not yet been used on a large scale. Thus an alloy containing platinum and cobalt has good magnetic properties, but is too expensive for commercial use. Magnets made of iron oxide powders are very light and are not easily demagnetised, but they cannot be used where a large field is required. There has also been some interesting research on making magnets of very fine powders. It is claimed that by this process permanent magnets can be made even of pure iron.

The author wishes to thank the Permanent Magnet Association for permission to publish this article, and those member firms who have loaned illustrations or given facilities for photographs to be taken; also Dr. K. Hoselitz for valuable advice and assistance.

The officers of BIOS (for those unfamiliar with these initials, they stand for British Intelligence Objectives Sub-committee) have had an unique opportunity to study what happened to German science and technology under the Nazis. The author of this article is a scientist who has spent many months on scientific intelligence work for BIOS. He records his personal views on corruption of German Science by the Nazis.

The Fate of German Science

IMPRESSIONS OF A BIOS OFFICER

THE Nazi leaders were the deliberate protagonists of as thoroughgoing an anti-intellectual and anti-scientific philosophy as ever existed. The Nuremberg trials have revealed and punished the most unpardonable of the guilty, but a real analysis must go further; it must seek out the basis of that philosophy, and thus assist in purifying those levels of German society where it had taken deepest root.

One indication of the depth and the direction of this penetration has been given by the trials, this year, of the Luftwaffe medical men of Ravensbruck and other camps, whose examination revealed a conscious and deliberate cruelty existing of itself, which could not be excused by reference to higher authority. The controversy about the ethics of using their experimental results must not disguise the fact that in great part these results are valueless. It is no great discovery that if you put a sick old man outside, naked in the snow, he will die; no useful knowledge could come from experiments in which men were strangled while submerged in water. From the scientific point of view, such experiments are completely valueless, but they indicate in a terrible way the decay and a disintegration of German science.

It falls to the scientists of the rest of the world to consider, not only how far was medical science corrupted, but how far this denial of science had spread to other fields; to consider the allied question, too, of how far were German scientists equally guilty with the Nazi leaders. Should one equate them with the conscious plotters against society, or with the dumb, if frequently complacent, 'followers'?

If one appreciates the peculiarly privileged position of scientists and technicians in the modern technological machine, and especially in one so geared to a single purpose, War, as the Nazis', it is quite impossible to accept any suggestion that they were mere cogs. The position of German scientists in the recent past would alone dispose of that view. It was one of great eminence and respect, even if the eminence was sometimes the empty one of a professorship conferred for services rendered in a non-scientific field.

It was backed by State honours, and the financial rewards that the State could confer; behind it stood, as proof of State recognition of Science, the Kaiser Wilhelm Society, which was originally the product of some fine ideals, but which soon became integrated with the militaristic structure of the German Empire. The German people possessed a great respect for learning which was to a considerable extent justified by the achievements of such nineteenth-century scientists as Liebig, Helmhotz, Humboldt, Röntgen and Hertz; but this attitude suffered distortion, with the growth of German heavy industry and of the nationalist idea. German scientists themselves tended to become part of the permanent reactionary forces of the German State.

When Hitler came to power a large proportion of German scientists and technologists either became practising Nazis, or like the Junkers, while disapproving of the crudity of the Nazis' methods, accepted the results. In acclaiming the martyrs, in welcoming the additions to world knowledge of Einstein, Goldschmidt, Stern, one is, without possibility of mistake, damning those German scientists who saw what was happening—and did not protest.

They damned themselves too, deeply and irretrievably, in accepting the pseudo-scientific pronouncements of the Nazi leaders. Neither laughter, nor argued rebuttal greeted such statements as this of Franck:

> "The blood-substance of the German race constitutes so pre-eminent and unique an asset to the world that we should be justified in counting it the duty of the entire human race, in gratitude, to safeguard the Germanic element";

this of Krieck, once Rector of Frankfurt University—

> "What is the purpose of University training? It is not objective science, which was formerly the purpose of university education, but the heroic science of the soldier, the militant and fighting science";

or this of the Führer himself—

> "Our first aim must be the development of character, especially of willpower . . . Scientific training must follow far behind."

These men fill the description of the 'Aryan' spirit given by Lenard, the Heidelberg physicist—"empirical, anti-theoretical, fact-accumulating, unmathematical, averse from paradox"—and among them could spread the idea that there existed a particularly 'German' science, the product of 'German' minds. The disastrous effect of this on the judgment of the 'German' scientist is illustrated by a further comment from Lenard, on Hertz's *Mechanics*; "I could follow his trains of thought only with an effort. I did not recognise till later that they were the trains of thought of an alien race, and so necessarily different from my own."

Passive acceptance of this nonsense is not by any means the only proof of the departure of German science from objectivity; for any respect for the cultural and international aspects of science had gone long before the beginning of hostilities. The part of German scientists in the exploitation and ruin of Poland is an index of the corruption which,

by that time they had undergone. Without protest, they saw, first, the forbidding of teaching and research activities in all scientific fields, then the looting of the laboratories, and the closing of the Universities, Colleges and Institutes. In the looting of laboratories they assisted; they concurred in the driving out of the whole professorial staffs at Warsaw, Poznan, Cracow, Torun and Gdynia, starving and penniless, or their herding into the camps of Sachsenhausen, Oranienburg and Oswiecim, where they died in hundreds. Ignorant of the existence of concentration camps as a section of the German people may have been, here was one section of the German people who knew something of the physical extermination and mental torture that the Nazis practised in every country they invaded. It was a German physicist who looted the Warsaw Institute of Experimental Physics, rich with apparatus on its $50,000 grant from the Rockefeller Foundation; it was German men of science who selected the most valuable instruments and books from the Institutes of Botany, Zoology and Plant Physiology and smashed the microscope slides and apparatus they did not want.

A group of professors from Eberswald requisitioned the instruments of the School of Rural Economy and the Research Institute of the State Forests; other professors looted the Mining Academy in Cracow and supervised the turning of the machine laboratory into a garage. These were not the men to protest, as they became hardened in their ghastly pilgrimage over Europe, and the piles of wrecked apparatus in European laboratories, and booty stored in German ones, became greater. Yet there was something uneasy and conscience-stricken in their attitude, for which it was necessary to compensate with further pseudo-scientific racialist explanations at the expense of the conquered nations and an arrogant attitude to their victims, as witness the professor from the new German University of Poznan who said to his Polish colleague, whose laboratory he was looting "Don't you delude yourself into thinking you'll ever take up scientific work again: there's a definite end to that." In this he was admitting both the quality of that work and his fear and hatred of it.

However, few German scientists failed to make the adjustments necessary to excuse German aggression to themselves, adjustments which were complete mental somersaults, and resulted in the most distorted outlook conceivable. Typical is the German senior technician of Krupps, lamenting still in 1946 the Russian recapture of Nikopol, which had in his words 'robbed' Germany of manganese. In the phrase "After we had put in machinery, too!" lay the deepest of amazement, and a sense of blackest ingratitude suffered.

Wehrwissenschaft without a Master Plan

At this pitch of irrationality, German men of science, previously well enough disposed to authoritarianism, were at their closest harmony with the Nazis, and they might have been expected to constitute a terrific weapon in the hands of the Third Reich. Fascism should have been able to harness technology to War; *Wehrwissenschaft*, undistracted, undeviating, should have taken its place alongside the other Services. It does not appear to have done so. Integration of science with the war effort required planning, but planning was notably absent; there is every evidence that for the greater part of the period of Nazi rule, considerable confusion reigned, a confusion that in certain spheres even survived the Speer Ministerium and continued till the end of hostilities.

For example, it is common knowledge that a super V-2 was planned, known as A-10, capable of reaching New York from Germany, but parallel with this, hindering it and each other, there was being developed a whole host of guided missiles, which competed for materials, for man-power, experimental facilities, and the interest of the authorities. The last factor may have been extremely important in the last panic-stricken months, when such men as Goering would frequently delude themselves and their associates with extraordinary tales of the hosts of new and invincible aircraft, for example, which were just about to sweep the Allies out of the sky, supporting their statements with threats and abuse against the corrections of better informed people. Given this irresponsibility among the leaders, what was there to prevent the head of a research team convincing himself that he alone had the secret which would save the Reich and that it was his duty to develop it, no matter how much it hampered and competed with his colleagues' work?

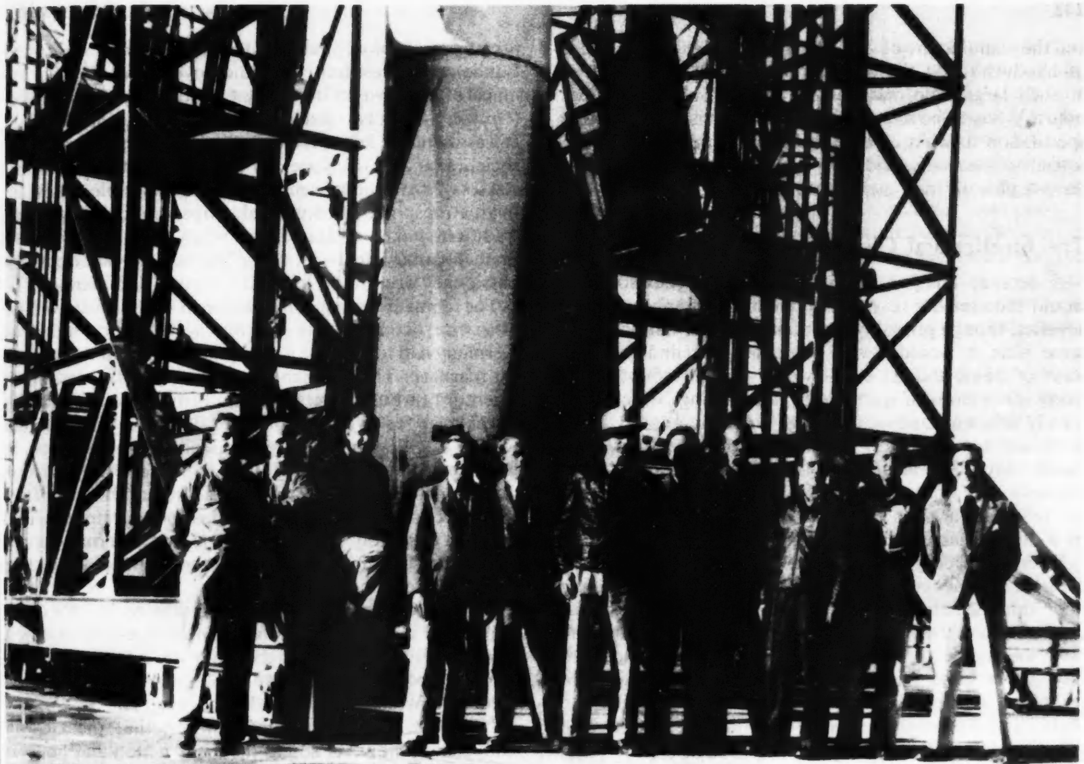
A clear recognition of this state of affairs has recently been shown in an American statement that the exploitation of German guided-missile work has advanced American knowledge by ten years; one may be non-committal about the period involved, but what is indicated is that German work in this field was so confused and undirected, and yet so considerable in mass, that a scientific study and redirection of it has produced considerable valuable results.

One field, now perhaps of academic interest, yet critical at the time, where German science and technology failed, and failed heavily, was that of strategic air attack. There are considerable doubts of course as to the general effect of this: it is claimed that the effect on German economy, up to a very late stage in the war, was only to cause a 10% drop in production, and that German war production reached its all-time peak in late 1944. Nevertheless, it can hardly have been a realisation of this fundamental uncertainty that caused the differences between the British and the German approach.

Guided Missiles *v.* Strategic Bombing

Both nations, in fact, attempted the same problem, the dropping of the maximum amount of high explosives on industrial towns with the minimum loss of aircraft; the problems of countermeasure and defence were similar too. Indeed, it can be said that the British defence problem was the more difficult, since the room for defence in depth was shallower, and the arc over which attack might be expected was far greater.

One can judge of the efficacy of each solution by comparing the aircraft which each side developed, and the actual results of the destruction. Starting with a bomber force which was small and obsolescent against an opponent with machines which were both superior and more plentiful, the British out-designed and probably outbuilt the Germans. They produced speedy and well-armed machines with enormous bomb-loads and considerable



Many German scientists and technologists have gone to Britain, the United States and Russia. A large proportion of them are continuing to work on military weapons which at the end of the war were far from perfect and capable of considerable development. These German rocket experts have been working at the U.S. Army's testing grounds at White Sands, New Mexico.

range, capable of finding a small target by night across a great depth of well-defended country. The Germans never produced in quantity a machine which was capable of flying overland the length of England of dropping a 2000-lb. bomb into Windermere, at the same stage of the war as Gibson performed the equivalent feat at the Möhne See. Mass raids of the 1000-bomber order were never at any time within their scope, for reasons both of quality and quantity.

The guided projectile was conceived as an alternative to piloted planes, for a limited purpose, but it was conceived far too late. When it reached production it proved an extremely costly and rather inaccurate weapon, because it was the product of a state in which offensive and defensive moods alternated; there was much confusion of intention, and an absence of planning.

The realisation that Germany might have to defend herself and possibly on German soil at that, came no more speedily than the realisation that the 1941–42 blitz had done Britain little real harm. When the appropriate measures were produced, though not individually ill-conceived, they lacked conviction, the conviction of a scientific plan. The brains capable of planning, of comprehending the new elements required, were simply not available. In Germany's crisis piecemeal solutions were all that were attempted; technique in abundance was available, since the conditions had been conducive to technique and not to discovery. But it was then too late for technique alone to save the country.

The investigations of German industry made possible since the conclusion of hostilities have shown that it was equally true of a large section of industry that it was technique that had been more important than discovery. While in the refinement of technique, a certain amount of discovery is inevitable, the main trends of German industrial development under the Nazis were towards technical advance and the development of known processes, rather than to the conception and exploitation of new ones. The combination of a regimented science and an advanced industrial civilisation does not, it seems, produce the remarkable results expected of it.

One remarkable failing of this combination is to be seen in the field of manpower. The promise of full employment made by the Nazis was kept, but along with the fulfilment of that promise went the most inefficient use of manpower; the semi-slave labour of the construction gangs, in such civil engineering projects as the *Autobahnen* is, however, paralleled by a most prodigal use of manual labour in industry, and especially heavy industry. Semi-automatic processes, 'automatic' processes, even, have been recorded which employ almost as many men as a completely manual operation, in fields as far apart as blast-furnace charging

and the manufacture of small die-castings, while the amount of handwork and the overall number of men employed in such large-scale manufacture as the Solingen cutlery industry has to be seen to be believed. It is an interesting speculation to what extent the Germans might have been forced to mechanise industry had they not had Europe's slave-legions to man their factories.

The Intellectual Climate of Germany

A detailed analysis of German wartime development would indoubtedly reveal a considerable number of discoveries, though probably less than in a freer nation of the same size; it would reveal some original and superior ways of doing things; but it would beyond doubt reveal many more cases of methods of doing things which were merely different, and which range from the notably more inefficient to the merely more roundabout. It has been stated that "Germans avoid the simple methods"; it is certainly true that they choose different ways, and are apt to obtain a given end by a greater number as well as by a different association of steps.

Without theorising about the 'German mind', it is still possible to draw certain parallels between the painstaking and unimaginative development of certain technical methods, and the irregular growth of the Prussian State from the middle ages, to its recent extinction in the present day. It is quite fair to seek parallels for science and technique in the historical development of the German State, and extremely valuable to compare affairs with developments in Britain.

The course of British industry under capitalism has been marked, it is true, by excessive waste in all directions, by inefficiencies, by the crude and near-sighted forms of exploitation of materials and manpower, but, during its peak period, when England was the world's manufactory, and London its money market, conditions were favourable for the growth of a science which was comparatively free, international, and humanitarian in its outlook. Aided by the rapid commercial expansion of the time, scientific discovery and technological progress were in a sellers' market, a market, moreover, into which the scientist himself could frequently enter as his own entrepreneur, since technological development did not involve large capital outlay in those days.

The scientist, too, was still a long way from becoming the complete employee: he was, on the contrary, still very close to the seventeenth-century gentleman, philosopher and dilettante, and had inherited from him the Protestant outlook, speculative and anti-authoritarian, which has provided a useful basis for progress in many intellectual fields.

At the latter end of this period of expansion the scientist was on the way to becoming an employee, but not directly in industry; he was frequently a professor or lecturer in one of the new technological institutes which were set up to give a necessary scientific training to a section of the labour force. The products of these institutes were, in a few generations, vastly to outnumber their predecessors, but these latter did not have to suffer the same restrictions. To some extent, the liberal Protestant tradition and 'enlightened self-interest' prevented this; it was realised that technical advance could be canalised and made a private possession, but fundamental work could not. Fundamental research was, moreover, too chancy, too much of a long-term investment for the commercial mind. (Only in the last two generations has this outlook changed.) It was therefore left to the older Universities, to the learned societies, and to the State. In the hands of the two former classes of institution scientific research was able to develop in an atmosphere of considerable freedom, carrying on the tradition spoken of above, and when at a later stage, the State became interested, there still existed sufficient dispassionacy of attitude to resist too rigid domination.

The climate among German men of science was far otherwise; coming late to the world fair, industrial Germany had to sacrifice a good many things in the struggle for markets. The German bourgeoisie had to pass in half a century through stages that the British had been able to linger over for two-and-a-half; in doing so, it was forced to rate a large number of things, science among them, in terms of utility-value, and that at its lowest, of utility-value to a nationalist state. In building up this state from the collection of dukedoms, principalities, electorates, etc., Prussia, inevitably from its internal and external circumstances reactionary, took care that the means of instruction were in 'safe' hands.

It surprises even enlightened Germans to be told of the haphazard growth of the British Universities; the strangest thing of all being the fact that they are not State institutions and because of the multifold sources of their endowments, enjoy considerable independence.

It should not surprise us, however, that the German Universities, however sound their instruction and however eminent their Professors, could not be regarded as homes of liberty and tolerance. Founded at earlier stages in the development of the German people, these Universities were often provincial (in the geographical sense of the word), and reflected the miniscule culture of the small landlocked states, at the same time as they tried to integrate themselves with the national solidarity.

Britain developed, because it could afford to do so, free men of science; Prussia, on the other hand, slowly, patiently and arduously developing till the time was ripe, could not afford more than a qualified liberty for its own bourgeoisie, and could certainly not afford to breed men of science who might question the divine mission of the State.

That would be the whole story, and this section of the German people would escape with the excuse "We could not help it, it was forced upon us", were it not for one thing: that no one can be more aware of the impact of militarism and imperialism upon science and education than men of science and culture. Science and culture have become the most intimate concern of the State, and any change in the State's outlook on these matters is unmistakable. The temper of the Prussian administration in these fields was quite unmistakable, as unmistakable as the attitude of the Nazi party. In neither case did the scientists make any vigorous protest though it was not impossible for them to have protested in the last quarter of the nineteenth century and it was not impossible for them in 1933. Indeed in the latter case it would have been easier; German scientists would not only have had the support of the scientists of the world, had they protested in strength; they would have won the support of the German organised working-class

movement itself, and a combined effort might have prevented Hitler coming to power. As it was the working-class, for good reasons, did not trust the bourgeoisie, and made no overtures to them, while the bourgeoisie refused to approach the working-class on matters of common vital interest.

It is indeed still extremely hard to find any appreciation among German scientists, in the British zone at least, that science is a matter of public interest; there are, for instance, no clues to the existence of the equivalent of an Association of Scientific Workers; the possibility of the latter is definitely a strange conception to them; they are apt to compare it with the professional-technical bodies which used to exist to a greater number even than in Britain, and the policy-forming aspect is almost as strange to them as the Trade Union one. Even the 'repentant' among them are loth to consider forming or joining any new organisation, pleading that one of the ways that Nazism fastened its chains upon them was by replacing the leading figures in the professional bodies by Nazis—once again the weak argument that "it was all beyond our control"!

The Future of German Science

But there is enormous scope for such an organisation, for the German scientist seems to be drifting in a social vacuum, without contact with other classes. His personal position is dangerous and precarious, with the reduced scope for scientific work under the level-of-industry plan, even if raised 50% above the present: large numbers of the most highly qualified men are looking outside Germany for employment. As far as residents in the British and U.S. zones are concerned, their first hope is the United States; as terms of employment are apparently better over there than in Britain, British employment comes a poor second in their calculations, though it is still more desirable than employment in Germany.

None, apparently, contemplates making a career in other European countries, though short-term employment is sometimes undertaken. There is basically a keen desire to get out of the Europe they have helped to ruin. There is also a hatred of Russia which is almost pathological, and a large proportion of the anti-Soviet rumours circulating in the British zone originate with the German professional classes, yet in the struggle for existence which is the German scientist's lot today to an even greater extent than the average German citizen, some are not averse from playing a double game, and using the threat of going to the Russian zone as a lever to obtain better employment in the British; if this fails, as it frequently does, the practiser of this stratagem has been known to go quite cheerfully into Russian employment.

The industrial chaos of Germany is also having another disastrous effect upon scientific personnel, besides forcing them to abandon their own country; it is frequently forcing them to abandon their profession.

In the German Universities and Technical Colleges, all evidence shows that the student body has to face enormous difficulties; it is already, in average age, above the best time of life for learning, it is short of books, equipment and space. The allegations that denazification of academic staff has been inadequate, however, are not wholly true; a recent examination of this question in one Technische Hochschule established beyond question that no important Nazi had been reinstated, though the number actually purged was few. What, in fact, had happened was that the staff had denazified itself: 30% had not applied for reinstatement! The academic machine is therefore under a very great strain, and the chances that the next generation of German scientists will have adequate training, even if opportunities for employment are available, seem poor.

It is not very evident that the British authorities in Germany have considered, even to the same extent as the British Government, the relations between science and society; control, at present, is in a negative direction. War science is reasonably adequately prevented; peace science is not yet adequately fostered.

Some observers suggest that things may be slightly different in the Russian zone, and that science and technology may be more closely harnessed to reconstruction there; it certainly seems to be the case that a number of refugee scientists have returned to the Russian zone from Sweden, the U.S.A. and from Britain.

Be that as it may, the extermination of the remnants of Nazism within the scientific profession is not an easy task. It cannot be done by legislative decree, but only by the greater integration of science with the life of the German people. It was because science was never brought down to the German people, but only worshipped from below, that men like Humboldt, Liebig and Hertz were replaced by the Francks, Kriecks and Lenards of this century.

To make the German scientist as well as the German man-in-the-street realise this is one of the ways to the solution of the German problem; the absolutely necessary counter-propaganda to the authoritarian beliefs which still permeate German science. It offers great possibilities for a real education in democracy, among a section of the population extremely susceptible to despair and defeatism, which, if allowed to decline into isolationism, will prove as good friends to reaction in the future as in the past.

Leading these people into democratic ways is the one of most important tasks of the occupying powers. Men of science the world over are more and more rapidly seeing the criminal folly of the statement that "Science and politics do not mix"; to the extent that there is adopted the opposing and positive attitude that politics *is* the concern of the scientist because his work is the intimate stuff of politics, will the world become safer, for Germans as for anyone else.

But this realisation must be fostered among the German scientists themselves. To guide them into organisation, to set them discusssing the functions of science, to bring these organisations into contact with the organisations of other workers, and so to indicate the common basis of their problems, should be the task of the occupying powers, and in this there is an obvious part for the organised scientists of the rest of the world to play.

Failure to play this part will result in a further degeneration of German science, a lowering of professional standards, a weakening of professional unity, and a reduced resistance to reactionary propaganda. Success may result, once and for all, in blowing the cobwebs out of the German mind, and placing its great potentialities at the disposal of the civilised world again.

The Forestry Commission's high-elevation experiments in Beddgelert Forest, North Wales, to test the tolerance of various species of forest trees to exposure and high elevation.

What is Forestry?

Continued from p. 204

J. D. U. WARD

WHEN a mixture of two or three species is grown, the work of thinning tends to be more complicated and to call for more skill. It may rest entirely with the forester whether the final crop is a mixture of two or three species or consists of only one. A similar position exists (though it is stretching the word 'thinning' a little to mention it here) when one species of tree is grown as a nurse to another. Scots pine, for example, was commonly planted with oak to serve as a nurse. Now, the nurse will almost certainly smother the child if she is not cut out when her work is done; the country is in fact dotted with Scots pine plantations which were intended to be oak, but the pine nurses were not removed when they should have been.

To select at the age of thirty years (say) those 200-odd trees which will form the final crop out of nearly 1000 trees standing on every acre calls for considerable skill. The forester has to decide not merely which are the best trees now, but which are likely to make the best, all the circumstances considered, fifty to eighty years later. High pruning is expensive and yields no immediate returns, but progressive modern foresters are tending more and more to stress the wisdom of this treatment for the final crop trees, where good quality softwoods are being grown to full maturity.

Reference has already been made to certain plant pests, such as clematis and honeysuckle, but the forester has also to contend with the attacks of various fungus pests. Three whose effect may be devastating are the honey fungus

(*Armillaria mellea*), *Fomes annosus* among pines, and canker among larch. Then there are also insect pests of many different kinds: *Evetria buoliana*, the pine-shoot moth, is an example, and the posthorn damage which it causes is a common sight in some pine plantations. The caterpillar of the moth weakens the leading shoot so that it droops but does not die; later the shoot recovers and bends up again, but there remains the kind of malformation illustrated below. For most of such fungus and insect pests there is no really satisfactory cure, but it is usually (and reasonably) held that mixed plantations are less susceptible than pure plantations to serious damage.

Frost, especially late spring frosts which come when trees have already flushed, are another cause of serious damage about which a forester can do practically nothing once his trees are out of the seedbeds—where they can be protected by shelters. Every forester knows, however, that the effect of frost is, by and large, most severe near ground level; in almost any forest one can see young trees whose growth was retarded for five, ten or fifteen years by late spring frosts, but which, having attained a certain height at which the leading shoot is above the ordinary frost level, proceeded to grow at great speed, and to suffer little further frost damage.

When old woodland is being replanted, a useful measure of protection from frost is often obtained by leaving a number of the old trees, which may be mere scrub or otherwise worthless, to act as nurses, on a modification of the nurse-child principle already mentioned. Indeed, it is easy to clear too thoroughly ground which is to be replanted, but where open grass or heather land is to be planted, the young trees must take their chance without any protection.

Not the least of the troubles with which the forester must contend are careless and thoughtless human beings. People are accustomed to the idea of forest fires abroad, but forest fires also do grave damage in this country. In 1938 (the last year for which full figures are available) the State forests alone had 1144 fires, whose average cost was over £35 each. Sparks from trains caused 475,* the general public 218 and 171 fires spread from adjoining land. Fires are specially liable to start in young plantations under fifteen to twenty years of age, before the canopy has entirely closed and destroyed the ground vegetation. In 1938 the State forests had rather fewer than 350,000 acres of such plantations, but the post-war programme, when fully under way, will give the country more than 100,000 acres of new plantations every year for some years to come. It is unnecessary further to stress the need for all care by the public, and for increased consciousness of forest fire risks, nor is it surprising that some authorities would like to see a strengthening of the anti-trespass laws, as applied to forests. A cogent point was recently made in the House of Lords: whereas the careless trespasser in a wheatfield destroys one year's crop, the fire-raiser in a forest destroys the crop of several years.

Fires are not the only mischief wrought by people. Gates left open will admit farm animals and rabbits, both of which can do the most grievous damage in a very few hours. At one time there was even a local craze for tying the supple leaders of Douglas firs into knots! From both State and private plantations 'Christmas trees' (Norway spruce and Douglas fir) are every December stolen by the thousand, and innumerable ornamental trees, planted to improve the roadside boundaries of forests, have been 'lifted'.

A layman, glancing at a few of the countless troubles which keep foresters on their mettle, must not allow himself to be distracted by unfamiliar details (the 'how' of forestry) from the main target, the production of a crop of timber which must be harvested when ripe. Unfortunately, the harvesting of timber nearly always evokes protests from country lovers. At the moment, however, popular objections are directed less against felling than against planting, perhaps because the present emphasis in forestry operations is, for obvious reasons, on planting rather than felling! A perfect example of the popular attitude is given by Ackers in *Practical British Forestry*. Having felled some trees, Mr. Ackers was told, "we miss the shade so much on our walk to church". The area was replanted and in a very few years criticism came from the same source: "It's nice to see your trees growing so well, but it's sad they are hiding out the lovely views you opened up."

Amenity and aesthetics have their place, but it must usually be a secondary or incidental place. Sylvicultural operations—weeding, thinning and the extraction of timber

The larvae of the pine-shoot moth feed on the leading shoots of pines, especially Scots pines. An attacked shoot is not usually killed, but is so weakened that it droops. Later it recovers but there remains a permanent legacy of the attack—the 'posthorn effect' seen here.

* Of the hundreds of fires caused in State forests by the railways between 1919 and 1939, there were nineteen in which the damage ranged from a minimum of £210 to a maximum of £2200. Yet the railways are protected by law from having to pay compensation exceeding £200, unless negligence is proved.

—require that trees should be planted in straight rows, in the same way that hops or kale are grown in straight rows. The rows may be displeasing to the eye, particularly on hillsides, but they cease to be obvious within fifteen to twenty years and generally disappear altogether within thirty years, just as the rows disappear from a wheatfield when the crop attains a certain height.

The use of straight lines for the actual boundaries of forests, for firebreaks, for inner compartment divisions, rides and extraction routes is not so necessary, and in some instances (especially in mountainous areas) the criticisms of forest lay-outs between 1920 and 1935 were well founded. There has been some modification of forestry practice in recent years, and critics who observe with distress what was done in 1925 need to beware of flogging a dead horse. Modern practice was outlined so well by Geddes in *The Scottish Forestry Journal* of August 1944 that two long quotations may be permissible:

> Afforestation at the government forest of Inverliever, Loch Awe-side, Argyll, shows how in the last twenty years planting based upon close botanical survey of the flora has led to 'landscape gardening' which could hardly have been equalled by deliberate design. Yet, so far as I know, the aesthetic result has been unnoticed. . . .
>
> Briefly, it (the method) consisted in noting the main 'plant communities and associations' (such as natural oak groves, rushes with certain grasses, mixed heaths and grasses, or heath alone), and planting on the patch mainly covered with one such 'community' the kind of tree which, as experience showed, grew best where that 'association' had been found. . . . Thus little areas were formed, each naturally suited to be the habitat of some species of forest tree. These tree groups, though parts of one forest and of one forest plan, also revealed, in a new way, the forms and character of the landscape underlying the forest floor, where rectangular blocks, so practical-seeming on paper, would have given very variable growth on the ground. Whether one viewed the hill slopes across the loch, from a distance, or saw them as one walked through the forest, the picturesqueness of this genuinely scientific planting was remarkable. A mixture of species is also being adopted increasingly—again a return to nature, and thus to natural appearance also.

Pure crops of conifers tend to impoverish some soils, and mixtures or alternate rotations of conifers and broad-leaved trees may therefore be preferable in many situations even on the most strictly utilitarian grounds. It is necessary to strike a balance. In the past, there was a great demand for oak, and oak was planted in some quite unsuitable positions; there is to this day, even after six years of war and the most drastic reduction of imports, a surplus of low-grade oak (as may be seen in the Dean and New Forests) resulting from the ill-judged plantings after the Napoleonic wars, yet when we have wanted good quality, easy-working oak we have had to import from abroad. At present the great demand is for softwoods, and where new land is to be afforested the best 'pioneer' species are usually to be found among the conifers (especially pines and spruces) which provide softwoods. But where old, clear-felled woodlands are being replanted or reafforested, a mixture of conifers and broad-leaved trees may well be preferred. The factors to be considered are often complex, and it is difficult to state general principles, but two facts should be clearly understood: (1) afforestation and re-afforestation are not the same thing, and (2) a tree that is naturally a 'successor' species (e.g. beech) may be poor or useless as a 'pioneer'.

The future, more generally surveyed, is full of interesting possibilities. Sylviculturally, there may be startling developments from the use of polyploids (both natural polyploids and polyploids induced by colchicine treatment) which grow rapidly and to a much greater size than the normal. These matters are still in the earlier stage of investigation by geneticists rather than by foresters—who have humbly to acknowledge that there are as yet no parallels in the forests for man's achievements in increasing the productivity of cows or wheat plants—or even roses!

In the field of timber utilisation, the comparatively new cellulose and plywood industries may have a revolutionary influence on what we need from the forests. For pulpwood, for example, small and medium-size spruce is best, and for plywood not only beech but also sycamore and birch (two broad-leaved species that were until recently of relatively low value) are good. Again, it is conceivable that the predominant influence of the mines' demand for timber may in time be modified, for the coal mines are worked chiefly for the sake of the energy they yield, and other sources of energy may have been developed and adapted for industrial use before another twenty-five years (say half the life of a tree grown for pit-props) has passed. The enormous quantities of timber used for telegraph poles and as sleepers on the railways suggest two other fields in which changes in communications and transport might affect forestry. (It has been computed that every mile of railway requires the produce of three acres of first-class forest—and the sleepers must be renewed every ten or fifteen years. Even so small an item as matches means the burning of about one acre of forest a day; the importance of the quick-growing poplars lies partly in their utility for making matches—an end to which spruce is also put.) Exactly what the future may bring is anyone's guess, but it is worth noting that the common idea that the development of substitutes is reducing the need for timber is ill-founded: as fast as one use passes, another is found; the farmer may use steel instead of wooden wheelbarrows, but the hosiery manufacturer proceeds to take up the surplus for making artificial silk.

The time factor is, of course, one of the forester's major difficulties. He has to guess now what timber is likely to be needed most two or three, or even five or six human generations ahead. This long-term time factor is one of the strongest arguments for bringing an increasingly large proportion of our forests under State control, to ensure some kind of continuity in sylvicultural policy—especially necessary when a forestry programme is planned to cover fifty years, as in the official report issued in 1943 (Stationery Office, Cmd. 6447).

In conclusion, a brief and 'utilitarian' summary. Most of our forests and woodlands have hitherto been so badly neglected or mismanaged that the average yield of timber during the present century has been about one-fifth of what it should be, and the country, with about 5% of its area under forests, has been supplying about 5% of its timber needs. It would be optimistic, at the present stage, to calculate on dramatic improvements from polyploids or from some lucky stroke of hybridisation. But it has nevertheless been conservatively computed that by better sylviculture we shall be able to supply considerably over 30% of our timber needs if we have 9% (5 million acres) of our area under established forests.

The Chemical Society's Centenary

THE Chemical Society was a hundred years old on February 23, 1941, the anniversary of the inaugural meeting held in the rooms of the Royal Society of Arts with Professor Thomas Graham, who became the Society's first president, in the chair. Owing to the war it was not possible to celebrate the centenary in 1941, and the celebrations were postponed until last month when they were celebrated on an impressive scale.

On July 15 a colourful opening ceremony was staged at the Central Hall, Westminster, at which the president, Professor C. N. Hinshelwood was presented with a long succession of congratulatory addresses from other chemical and scientific societies all over the world. Social events during the three days of celebrations included a luncheon in honour of overseas scientists given by the Government, and a centenary dinner at which the Prime Minister, Mr. Attlee, spoke. Among the other social occasions was a dinner given by London University, a Royal Society reception attended by nearly 3000 people, and a Government Garden Party at Lancaster House. Another large reception took place at the Connaught Rooms, the hosts being Imperial Chemical Industries. Many delegates to the 11th International Congress of Pure and Applied Chemistry, which started on July 17, attended these functions.

In his centenary address, delivered at Central Hall, Westminster on July 15, Professor Hinshelwood set the foundation of the Chemical Society against its social background. There was nothing, he commented, in the obvious character of the time to announce a period of intellectual flowering, and yet it was just then that many learned societies, including our own, came into being. Scientific studies in England were hardly in any clear way the product of their age, and sprang more from the learned curiosity of amateurs than from the conscious needs of society. There were practically no laboratories for chemical research, and little or no university instruction in chemistry.

Turning to a consideration of the state of chemical knowledge at that time, Professor Hinshelwood pointed out that in 1841 the time which had elapsed since the 'chemical revolution' of Lavoisier was *almost exactly* equal to that from the discovery of radioactivity to the present day. Chemistry as a science was then as old as is now the new nuclear alchemy upon which we believe the future so largely to depend. It was difficult today for a scientifically educated person to realise how profound was the change of thought which followed the publication of the Lavoisier treatise. It represented a complete philosophical re-orientation of ideas on the nature of substance. Two Englishmen in very different ways had played parts of the first magnitude. Priestley, whose house was wrecked by a mob, had made the discovery which opened the way for Lavoisier, and Dalton, living in an obscurity which astonished his foreign visitors, had formulated the theory upon which all future development was to depend.

Between the time of Dalton and the foundation of the Chemical Society the great forward sweep of organic chemistry had begun, but in this the English school had played little part, as was explicable in a country which tended to produce a few of the finest flowers of science, art and literature without any very vigorous general growth of leaf and root. At the moment of the Society's foundation Dalton was still alive, but Liebig, who visited England at about this time, found little in the world of chemistry to inspire him. Yet Faraday was at the height of his powers and his great work on the laws of electrolytic action was already accomplished. Its full implications were far from obvious to his contemporaries, and indeed the confusions which Avogadro's paper of 1811 might have cleared away still clouded chemistry. On the Continent the great battle between the rival interpretations of the structure of organic compounds was at its height.

Such was the chemical scene at the time of our foundation. By 1861 chemistry had seen two decades of steady progress but had been on the whole unshaken by revolutionary changes. Cannizarro's paper of 1858 had removed one of the major obscurities and Frankland and Kekulé had placed structural chemistry on a firm foundation. In this country Hoffman, Mansfield, Williamson and Frankland are seen among the outstanding figures of the period. In England it was still mainly the affair of the amateur. Indeed, in 1867, the only technical education in Leeds (with its quarter of a million inhabitants) was provided by one teacher who worked in a cellar and held a class in chemistry, receiving a grant of £11 a year for the purpose.

Professor Hinshelwood devoted a large section of his address to what he described as 'the successive decline of individualism' during the hundred years the Chemical Society had existed. The independent craftsman, the aristocratic politician, the empire-building explorer, had all departed from the scene, and in science, he said, a similar trend had been visible though at a lag of several decades. At the time of the Society's foundation the stage was dominated by the amateur, whether a Cavendish or a Faraday: later the individual was more and more frequently dependent upon the university or technical college, small and independent but none the less a community. Then the great research associations appeared and the State subsidy becomes indispensable. Two great wars intensified and accelerated the collective process in the world of science until to-day we were faced with the problems presented by vast industrial research laboratories and by State enterprises undertaking work which was inconceivable without the co-ordinated efforts of hundreds of men of science. "The great question is what is to be the fate of the individual in the world which has emerged," he said.

A hundred years ago we saw an individualist society faced with the task of controlling the industrial revolution: at the beginning of a new century we faced a task which seemed even greater, that of preventing an organised society from turning individuals into slaves. The problem involved the relation of the State to science, of the industries to the universities, the organisation of research laboratories, and indeed the relation of every man of science to his laboratory and to the science as a whole.

"Those who call themselves planners are often, I think, not conscious enough of the art and effort involved in large-scale action. Even with the most admirable motives and goals operative complexity often brings frustration. There is need for a complete new science, a kind of biological and psychological statistical mechanics to clarify these matters. The beginnings of it exist. Indeed we have seen one gigantic manifestation of directed human activity in the evil arts of the late rulers of Germany, whose ingenious mechanisms were applied in opposition to truth and justice but might have been used to better ends. This thesis will be accepted readily enough by the exponents of what are now called social studies, but we may be told that the organisation of affairs must be placed in the hands of specially trained humanists, and that the scientific man should be confined to the role of an advisory expert. Such a tradition has of course crept into some of the public services. But nothing could be more false, and one can say with conviction that its persistence will be unfortunate and its extension disastrous. It is like a separation of the heart from the brain and of the mind from the body. The man of science himself handles the human problems, and in scientific affairs nobody but the man of science can do it. Any other arrangement is a sham and a mockery.

"On the whole the universities and the great chemical industries are aware of this, and the excellent relations which have been growing up between them will exert a powerful influence for good, and are of happy augury. But eternal vigilance is the price of these things. At every level in every organisation where men are engaged in scientific pursuits those in charge must continue to wrestle with the problems of combining liberty with order to the end of finding that course which is humanly as well as technically the most effective."

The 1947 Faraday lecture was delivered by Sir Robert Robinson, who was the president in 1941, the Society's actual centenary year. His subject was "The Development of Electrochemical Theories of the Course of Reactions of Carbon Compounds."

Two other lectures delivered during the celebrations, the first by Professor J. Read on "Chemical Personalities a Century Ago," and Professor E. K. Rideal on "The work of the Royal Institution in Physical Chemistry in Great Britain."

The Bookshelf

They Live in the Sea. By Douglas P. Wilson. (Collins, London, 1947; pp. 128, illustrated, 12*s.* 6*d.*)

THOSE who are fortunate enough to know the work of the Zoological Photographic Club, or whose interest in the Royal Photographic Society's Salon extends beyond the merely pictorial, will for long have been familiar with the work of Douglas Wilson of the Marine Biological Association's Plymouth laboratory. For many years now, he has been known as an outstanding expert on the life of our shores, and in a previous work (*Life of the Shore and Shallow Sea*), he has shown himself well able to interpret that life for the common reader. In this new book, however, he goes a great deal farther, not merely re-introducing us to the more common and better-known objects of the seashore, but opening up fresh territory that has previously been hidden ground to all but the marine biologist.

Here we see for the first time the stinging capsules which form the jelly-fish's armament; we are treated to a series of remarkable action pictures of the chase and capture of a shrimp by a cuttlefish; and, of especial interest to the zoologist, a set of photomicrographs showing details of the early stages of crab, barnacle and brittle-star.

This is, indeed, mainly a book of photographs, with sufficient text to enable the least-informed reader to know what they are about and relate them with such seashore fauna as he is likely to discover on his holidays. The natural orders of the creatures discussed are taken one by one and simply and lucidly explained without any attempt at 'writing up' and with a refreshing minimum of scientific terms. To many biologists, one of the most interesting chapters will certainly be that entitled 'Work on the Shore', a practical account which contains some remarks on 'collecting' which apply to a far wider field than the subject of this book. An excellent idea, too, is the inclusion at the end of the book of a list of the scientific names of the creatures referred to. (But why, one wonders, is there no index?)

Yet while the text is certainly a great deal more than a guide to, and explanation of, the photographs, it is inevitably to the latter that the reader, for whatever reason he picks up the book, will turn again and again. Some of these have already been mentioned. Less sensational, perhaps, but in many ways even more valuable, are such studies as those of the peacock and fan-worms (designers of printed material could examine these with advantage) and the set of fishes, variously camouflaged, lying on the bottom of the aquarium tank, culminating in the picture of a spotted ray (facing page 118) which is possibly the best thing in the book.

To complain of any omission in such a book may seem ungrateful, but there will be many besides the writer who will wish for further technical information from a photographic point of view. That these pictures are the outcome of many years collecting and experience we are told in the preface; that it is 'the mind behind the camera' and not the apparatus itself which produces such work, we are well aware. But a wide range of equipment must have been used for pictures covering so great a field, and with the growing interest in photography of this type, at which British workers excel, is it too much to hope that in his next book Mr. Wilson will let us into a few of the secrets of his technique and equipment? He need have no fear that we shall equal, let alone excel, his results.

The publication of this really excellent book may be perhaps a landmark in the literature of British natural history. In it, not only has the author attained his confessed ambition 'to fill, partially at least, this gap on the bookshelf of the amateur naturalist', but the publishers on their part have given us a volume which in its standards of production, as well as in format and appearance, can take its place amongst the finest editions in the naturalist's library.

P. B. C.

Researches on Normal and Defective Colour Vision. By W. D. Wright. (Henry Kimpton, London, 1946; pp. 383, 36*s.*)

Retinal Structure and Colour Vision. A Restatement and an Hypothesis. By E. N. Willmer. (Cambridge University Press, 1946; pp. 231, 21*s.*)

IT would be difficult to find two contemporary scientific textbooks as similar in subject and as different in spirit as these. It is a most interesting and instructive study in the diversity of scientific method to read them concurrently.

Dr. Wright's book is a record of twenty years of meticulous experimental investigations carried out at the Imperial College of Science; investigations which, besides forming the basis for international specifications for the sensitivity of the average human eye to light and colour, have immeasurably advanced our knowledge of the fundamental aspects of the subject of colour vision. He began by designing an instrument with which a wide variety of measurements of the reaction of the eye to lights of all colours and intensities could be made. With it he has measured, amongst other things, the sensitivity of the eye to light of different wavelengths (a function known as the *luminosity curve*, which varies over different parts of the retina and for different levels of illumination); the laws of colour mixture (that is to say, the proportions in which lights of various wavelengths must be mixed in order to match any given coloured light); the discriminating power of the eye for differences in hue and saturation; and the effects on all these quantities of adapting the eye to light of various colours and intensities before making the measurements. The characteristics of various types of defective colour vision have also been measured. This book will have a permanent place on the scientific bookshelf, forming a worthy successor to Sir William Abney's *Researches in Colour Vision*.

Dr. Willmer on the other hand has written a book of a much more ephemeral kind. Dissatisfied with the deadlock which exists between the physicists' assertion that there must be three independent receptors taking part in colour vision and the histologists' evidence that there are only two fundamentally different types of receptor cell, Dr. Willmer, as a histologist, makes the bold assumption that the physicists are wrong. He then proceeds to try to explain as many of the facts of colour vision as he can on the hypothesis that there are only two types of receptor—the well-known rods and cones. How far does he succeed? Certainly a great deal farther than the orthodox theorist would have believed possible. In fact he is able to suggest explanations of several phenomena for which none was available on orthodox lines. However, in the end, the physical truth is not to be denied and it is admitted that a third receptor must be found.

In spite of its conjectural quality and the out-of-date sources of some of the experimental facts, Dr. Willmer's book cannot be dismissed lightly. It has already stimulated a new experimental examination of the colour vision of very small fields, which has shown that in the central fovea even people with normal colour vision are colour blind. There is no doubt that it will stimulate many more valuable experimental researches before receding into the limbo of forgotten hypotheses.

C. G. A. H.

Plough and Pasture. By E. Cecil Curwen. (Cobbett Press, London, 1946; pp. 122, 14 plates and 21 figures, 7*s.* 6*d.*)

THE remarkable development of research in pre-history during the last three decades was bound to lead sooner or later to the appearance of an up-to-date work on the origins of agriculture and stock-breeding, and in *Plough and Pasture* that book has now arrived. With a background of some thirty years of spare-time archaeological study, during most of which the author has had the origins of cultivated fields, cereals, harvesting implements, querns and the like in the front of his mind, Dr. Curwen is eminently fitted for the task.

After a short introductory chapter on the Quest for Food, the author gets to grips with his subject in chapters II and III on the Origins of Agriculture and Stock Breeding. He points out that these two discoveries were essentially one—the control of reproduction in the plant and animal kingdoms. Although made at approximately the same time (the early Neolithic Age) they may have been made by different peoples, and in any case the cereals were grown by settled cultivators in the oases and river valleys while the flocks and herds (mostly ox, sheep, goat and pig) were bred by the nomadic tribes.

Among the most fascinating parts of the book is the account of the work of the Danish Scholars Sarauw, Jessen and

Helbaek in determining the type and frequency of the various cereals by studying impressions of grain on prehistoric pottery, and this and kindred matters are well illustrated by exhibits arranged by the author in the Barbican House Museum, Lewes (a point which his modesty prevented him from mentioning).

Chapter V on Ploughs and Fields reviews the development of the cultivated field from the tiny 'horticultural' corn-plots on Dartmoor and Bodmin Moor, perhaps Early Bronze Age, to the more agricultural Celtic Fields of Plumpton Plain (Sussex) and elsewhere on the chalk downs, and the strip lynchets of Mediaeval times. In his account of the origins and development of ploughs and other agricultural implements he draws upon such diverse material as the early Sumerian and Egyptian hoes, ploughs depicted on the Italian and Scandinavian Bronze Age rock drawings, and numerous later examples.

If a second edition should be called for, reference might be added to the work of Schweinfurth and Keimer on ancient Egyptian animals and plants, much of which is illustrated in the galleries of the Ancient Egyptian Department of the Fuad I Agricultural Museum in Cairo. *The Wheats in Classical Antiquity*, by N. Jasny (Johns Hopkins Press, Baltimore, 1944) might well be added to the bibliography.

As a readable and accurate summary of existing knowledge of the early history of cultivation and stock-breeding, with special reference to western Europe, this book should hold the field for many years to come.—L. V. GRINSELL.

Currents in Aerial and High-Frequency Networks. By F. B. Pidduck. (Oxford University Press, 1946; 97 pp., 8*s.* 6*d.*)

THE calculation of the propagation of radio waves through free space is comparatively easy, and the behaviour of non-radiating electric circuits is almost within the competence of the proverbial schoolboy. But there is a boundary land between these two provinces, comprising aerials which are designed to radiate the circuits in which the operating frequency is so related to the linear dimensions of the circuits that they are bound to radiate to some extent; and this book is an exercise in mathematical approximation designed to obtain a workable solution of these boundary problems. The solutions look forbidding, because expressed in the most general terms, but the mathematics should be within the capability of the engineer-physicist working on radio and electronic problems. These aerial problems are of great technical importance, and should, for example, enter into the design of the now familiar H-shaped television aerial, as well as the design of the multitude of specialised aerials required for radar.

An interesting feature of the book is that the mathematical tables printed in it are all extracted from tables published by the Federal Works Agency of the U.S. Works Project Administration for the City of New York. This is a reminder that probably the largest piece of work in mathematical tabulation which has been carried out in recent years was in the form of a "Public Works" programme, to counter unemployment during the depression in the United States. This project was terminated when the war brought full employment, but one hopes that in future it may be possible for work of such value to be carried on without having to wait for a trade depression.

D. A. BELL

The Soochow Astronomical Chart. By W. Carl Rufus and Hsing-Chih Tien. (University of Michigan Press, Ann Arbor, 1945; University of Oxford Press, London; pp. 24+2 plates, 14*s.*)

WHEN in the latter part of the twelfth century A.D., in the South Sung period, China rejected the state socialism of Wang An-shih and turned back to its older well-tried culture, instructions were prepared and set down for the guidance of a future emperor. These were engraved on stone in 1247, and the engravings are now in the Confucian Temple near Soochow in the Kiangsu Province. Among them is the astronomical chart with its text, which forms the subject of this book.

An ink rubbing of the chart, and of the text beneath it, is reproduced on a reduced scale and, after a short introduction, the authors give a translation of the text followed by a description and discussion of the star chart itself, and finally tables of the asterisms with translations and explanations. The chart, it is deduced, was constructed for the latitude of Kai-Feng Fu, Honan, the seat of government from 1214 to 1267, the stars being represented on the plane of the equator with the north pole at the centre. Its purpose was clearly astrological rather than astronomical. Following oriental convention, the configurations of stars were idealised in asterisms representing, among other things, the emperor, his court and his officials. It is probably the best ancient Chinese star chart that is known, and this description and study of it will be valuable to students of Chinese astronomical history.—G. M.

Plastics for Electrical and Radio Engineers. By W. T. Tucker and R. S. Roberts. (Technical Press, London, 1947; pp. 148, 12*s.*)

THIS book is an admirable and well classified review of a specialised field of application of plastics. The almost exclusive reference to British made plastic materials gives the book a somewhat domestic character, but this perhaps is the intention of the authors. An exception is in the chapter on melamine, where the name of the American producers is given but not those of the Swiss or British manufacturers.

It is unfortunate that so little space is given to the extremely important silicones.

In general the book gives an excellent survey on the subject without pretending to be a text book.

Perhaps more extensive quotation of literature, and more reference to British standard specifications, would enhance the value of future editions.—G. L.

Science Advances. By J. B. S. Haldane. (Allan and Unwin, London, 1947; pp. 253, 10*s.* 6*d.*)

FOR the most part this book consists of articles reprinted from the *Daily Worker*. The physiological phenomena which makes service in submarines so hazardous is one of the author's special interests, and the final chapter, entitled 'Human Life and Death at High Pressures', deals with this subject; it originally appeared as an article in *Nature*.

Osborne Reynold. By Professor A. H. Gibson (1946). **Sir Joseph Whitworth.** By Professor F. C. Lea (1946). **Oliver Heaviside.** By Sir George Lee (1947). **A Century of British Chemistry.** By Dr. F. Sherwood Taylor (1947). All four booklets are published for the British Council by Longmans Green, London; price 1*s.* 6*d.*

THESE are the latest booklets in the 'Science in Britain' series which the British Council sponsors. The biographical ones live up to the standard set by the booklets on Parsons, Watt and Ferranti. Dr. Sherwood Taylor in *A Century of British Chemistry* achieves a miracle of condensation in his thumbnail sketch of British chemical achievements since the foundation of the Chemical Society.

Calculating Machines: Recent and Prospective Developments and their Impact on Mathematical Physics. By D. R. Hartree, F.R.S. (Cambridge University Press, 1947; 40 pp., 2*s.*)

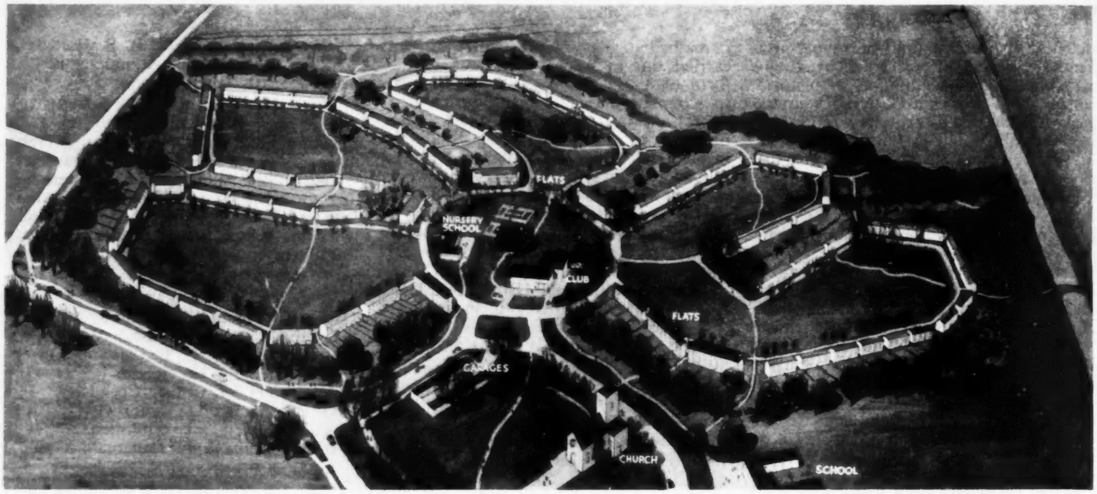
FOR a brief review of recent developments in calculating machines and their applications, this booklet containing Professor Hartree's inaugural lecture on assuming the Plummerian Professorship at Cambridge will be hard to beat. It is particularly valuable for his views on the ways in which the emergence of highly automatic high-speed machines will compel a remoulding of the methods of practical mathematics and of the methods of formulating physical problems in mathematical terms.

S. LILLEY

New Test Examinations in Mathematics. By A. S. Pratt. (6th Edition, Methuen & Co., Ltd., London, 1946; vii + 76 pp., 1*s.* 6*d.*)

The above bound with **'Section A' Tests in Mathematics.** By A. S. Pratt and G. H. Bonser. (8th Edition, Methuen & Co., Ltd., London, 1946; v + 40 pp., 2*s.* 3*d.*)

ANY adverse criticism that one might possibly level at this handy collection would in fact be merely a criticism of the present-day examination system. Given that system as it stands, the collection of test questions given here provides almost as good a training as is possible in the technique of passing School Certificate or Matriculation Examinations. 'Section A' tests refer to the easier papers set by certain examination bodies.



An example of a "Reilly unit" designed for Bilston by William Crabtree, of Johnson and Crabtree. (*Reproduced by courtesy of The Architects' Journal*)

Sociological Approach to Town Planning

THE BILSTON EXPERIMENT—A PROBLEM IN SOCIAL ENGINEERING

In 1916 Bertrand Russell in his *Principles of Social Reconstruction* stated that "the utmost that social institutions can do for a man is to make his own growth free and vigorous; they cannot force him to grow according to pattern". The recognition of the educational and developmental function of social planning is one of the most important advances in sociological thought. It has led to the realisation that grandiose schemes for architectural re-planning of slum districts and the planning of new communities are useless and of little value, even when extensive facilities for social service are also provided, unless they are coupled with an educational programme aimed at the individuals affected. It has arisen from an understanding of the real aims of social planning —that the object is not merely to house the people under better conditions and provide facilities for a higher standard of living, but to open up for them a new way of life; to give them greater scope to develop their latent individuality, and their latent interests both in work and leisure which are too often swamped in the struggle to obtain the domestic necessities of life. Social planning when not linked with such a positive aim merely leads to a temporary alleviation of living conditions and an eventual return of all the worst factors of the slums. The planning must be aimed at the development of the individual within the community, and the individual must develop through the planning, or communal sterility will result.

One of the pioneers of this new outlook in social planning or 'social engineering' was the late Otto Neurath. President of the Central Office of Planning in Munich after the 1914-18 war, he was afterwards founder of a research institute for social planning and general secretary of the Garden City Association in Vienna, and later Director of the Museum of Social Sciences there. He studied and advised on schemes of social planning in many parts of the world, and after the Dollfuss 'putsch' he fled to Holland where he continued his work until the German Invasion when he again had to flee, this time to England, where the form of visual education he introduced, the Isotype, is now so well known.

In the middle of 1945 Dr. Neurath visited Bilston in Staffordshire—home of Wilkinson and birthplace of the Industrial Revolution—at the invitation of the Borough Council in order to discuss with them the problems of the rehabilitation of the slum-dwellers. With his help, the Council started plans for doing this. Neurath insisted, as in Vienna, that no town planning is any use unless an attempt is made to approach the individual who is to be re-housed and to find out what he feels are his needs—to make him realise that the whole success of the venture depends on his taking his own part in its working. The people of Bilston must be told what conditions are already like—how many houses are good or bad; how many families have no house of their own; how there is bad air pollution, and how it affects their health, and many other factors. They must be asked for solutions to these problems and presented with possible solutions to criticise—how should the new houses be laid out? Who should get the houses first? Where should they be built? What about the children on the new estates?

> At Bilston a novel experiment has been tried out, which is interesting for the sociological approach that has been taken to the town's problems of re-housing and town planning. The solution of the problems shows how the skills of the architect and the building technician can be amalgamated with the ideas of the sociologist. The story of the experiment is told in three articles by Mr. A. M. Williams, town clerk of Bilston, Sir Charles Reilly, the architect, and Mr. D. Wragge Morley

They should be stimulated by questions and answers, proposals and criticisms, to take an interest in their future welfare, to make full use of the advantages of the plans proposed and play their part in their development and alteration, and in fact develop a new and active life.

Communal life should not be enforced, but allowed to develop naturally in those who feel the need for it. There should be the chance for privacy and communal life and leisure—facilities for eating, working and playing at home or together with their neighbours. All modern domestic and communal help should be provided both in the house and as community facilities. For example they should be able to cook or launder at home, or to get a meal sent round, or eat it at the community centre. The choice of privacy or community activity should be theirs.

He stressed that people with ties of friendship or mutual help should be moved together, and the old and young, married and unmarried, should not be segregated. Yet individuals should not be forced to move with other individuals whom they did not like.

At this point the Bilston authorities

saw the plan designed for Birkenhead by Sir Charles Reilly and felt that it provided in architectural form many of the ideas they had developed largely on the basis of what Neurath had suggested. The general idea of the plan is based on adjacent greens surrounded by houses forming small communities, each forming a part of a larger community consisting of several such greens. These are served by a large community centre with facilities for feeding, educational and leisure activities and a 24-hour nursery service.

It seemed to provide for the possibility of individual development on which Neurath had laid such stress. With Reilly's aid, plans were then put in hand and a start was made in preparing the derelict waste land for a new estate for housing the worst of the slum areas.

All this—both Neurath's ideas and Reilly's plan—was explained in visual form in an exhibition held in a slum shop in Bilston, and also in a carefully worded pamphlet in which the emphasis was on the suggesting of ideas and the posing of questions rather than on a dictatorial exposition. A model of a Reilly community for 500 people was also shown together with the proposed plans for Bilston.

A full-time social worker was provided by the Birmingham Area Social Service Federation to be at the exhibition all the time it was open to answer questions.

Clearly the Bilston venture is a bold and imaginative attack on the problem of dealing with industrial slum-clearance, and the Bilston Town Council deserves to be congratulated on the initiative they have shown throughout. This scheme will be followed with close interest by all those interested in progressive town planning.

DEREK WRAGGE MORLEY

The Details of the Problem

BILSTON, a small town in South Staffordshire, is one of the most startling examples of the exploitation produced by the Industrial Revolution, which exists in Great Britain. As early as 1315 coal mining was carried on in a very small way, the bulk of the coal coming from small surface workings on the famous seam of coal known as 'The Heathen', reputed to be one of the thickest seams in this country. Mingled with the coal there was iron stone, and when the enamelling industry, the industry for which Bilston had become famous, began to decline and the Industrial Revolution was on the point of commencing, Bilston was a natural centre for the production of cast iron.

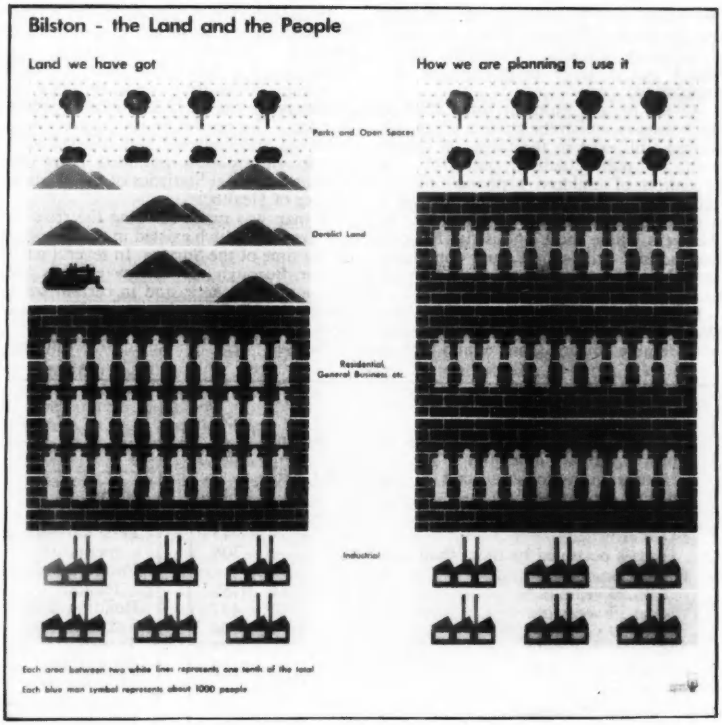
The 'father' of the iron trade, John Wilkinson, came to Bilston in 1756 and in 1767 established his first blast furnace for the manufacture of pig iron. At this time Boulton and Watt were experimenting with their steam engines and it was Wilkinson who made the first cylinder out of cast iron, thereby making the steam engine a cheap reliable source of great power. In 1775 Wilkinson installed one of these steam engines, reputed to be the first successful one of its kind, in his works at Bilston and thereby doubled the output of cast iron. In 1784 Wilkinson applied an improved form of Henry Cort's invention of the puddling furnace and rolling mill and from that time onwards the production of pig iron and wrought iron went up by leaps and bounds. In 1790, of the twenty-one blast furnaces in the country, fifteen were situated in Bilston.

The tremendous concentration on the production of metals was reflected in a great increase in the population.

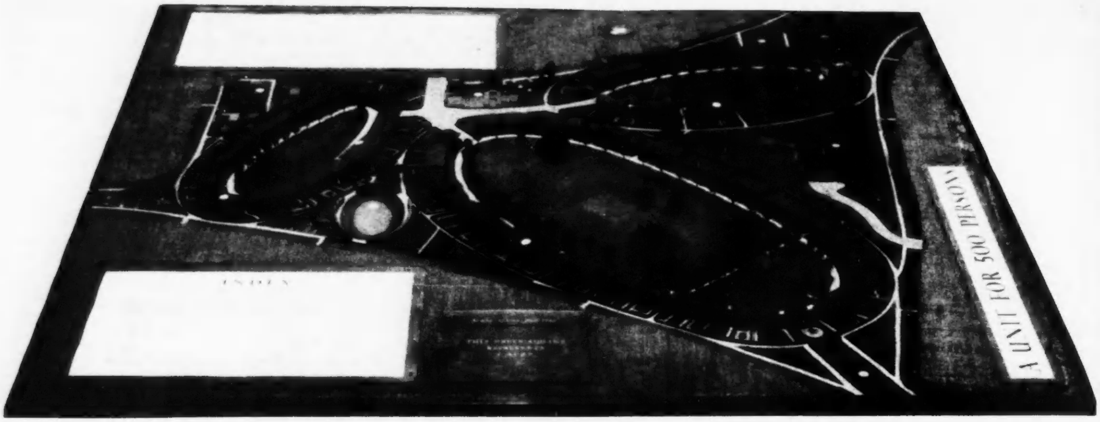
As the total acreage of the town is approximately 1800, it will be realised that the expansion of a trade so uneconomical in the use of space as the production of iron, tended to produce great congestion in the living quarters of the population. A large number of small houses were built in the shortest possible time and immediately on completion they became overcrowded to an almost unbelievable degree. Intermingled with this already congested development there sprang up scores of backyard workshops. A description of Bilston in the 1840's reads as follows:

"There are few manufactories of large size, the work being carried on in small workshops, usually at the back of houses, so that the places where children and great bodies of operatives are employed are completely out of sight in the narrow courts, unpaved yards and blind alleys. In the smaller, dirtier streets, in which the poorest live, there are narrow passages at intervals of every eight or ten houses and sometimes every third or fourth house; these are under three yards wide and about 9 feet high and they form the general gutter. Having made your way through the passage you find yourself in a space varying in size with the number of houses, hutches, or hovels it contains, all proportionately crowded. Out of this space other narrow passages lead to similar hovels, the workshops and houses being mostly built on a little elevation sloping towards the passage. The great majority of yards contain from two to four houses, one or two of which are workshops or have room in them for a workshop."

In process of time, as the inhabitants increased, small rooms were raised over



Bilston's problems and the suggested solutions were explained to the public in an exhibition. This was one of the Isotype posters shown there.



The exhibition also included this model of a Reilly unit designed to house 500 persons, providing the Social Services described in the article on the opposite page.

the workshops, and hovels were also built wherever space could be found and tenanted first perhaps as workshops and then by families also. By these means the increasing population was lodged from year to year while the circumference of the town remained the same for a long time, owing to the difficulty of obtaining land to build upon.

This description shows why it was hardly surprising that in the years 1842 and 1849, only just beyond the range of living memory, Bilston suffered from two tremendous cholera epidemics which wiped out a large proportion of the population.

At the present moment some 3500 of the houses in which the cholera epidemics started, still exist in the town. A school built by public subscription for the education of children orphaned by the cholera plagues also exists, but is now a workshop in the middle of a factory. In the areas where these 'Industrial Revolution houses' still stand, slum conditions as bad as any in the United Kingdom are to be found.

During the period between the two World Wars the Council undertook some considerable housing schemes and built in all 2,749 houses. In addition they demolished some 1,300 slum houses. In order to achieve a more satisfactory balance for its industry the Council levelled a large piece of derelict land and made available to industrialists excellent sites for factories on a small trading estate. Considerable though this work was, however, it still left the town in so bad a state that very drastic measures were necessary.

In 1944 the Council undertook a house-to-house survey in order to gain further detailed information concerning the problem. A questionnaire was prepared and was taken from door to door by members of the Civil Defence Wardens Service. The results of this survey were collected and analysed and collated with further information obtained from the Census and Vital Statistics of the Medical Officer of Health.

A map was made showing the residential densities which existed in the Borough at the time of the Survey. In several parts of the Borough the density exceeds 136 persons to the acre, and in certain small areas over 200 to the acre. These are very high figures.

Houses were classified in different groups according to ages and their condition (see Table I). It will be seen that out of a total of 7,700 houses in the Borough 34·1% were unfit for habitation, 23·08% were over 80 years old and 36·1% exceeded their economic life.

Furthermore no room could be found for even pre-fabricated houses without recourse to levelling derelict land. In many of the houses standards of sanitation were so low as to be almost non-existent. To make matters worse, the pollution of the atmosphere, while vastly improved since the time when no vegetation would exist in the area, is still exceedingly high.

In one area an observation by means of petri dish sampling produced an estimate as high as 13,000 tons of dust (containing mainly silica with some antimony and arsenic) per square mile per annum.

When faced with the problem of rehousing the occupants of the slum houses, the council found itself without any suitable land whatever; the only expanse of open land within the Borough were large areas of derelict land. As a result of the use of open cast and beehive systems of coal mining, this derelict land consists of mounds and hollows pockmarked with dozens of shafts of varying

State of repair	
Houses unfit for habitation	2655
Houses in reasonable state of repair, but no proper sanitary amenities	1176
Houses in reasonable state of repair and with proper sanitation	3940
Overcrowding	
Overcrowded	745
Houses occupied by more than one family	708
Age of houses	
0 to 29 years old	3752
30 to 39 years old	497
40 to 59 years old	704
60 to 79 years old	1024
80 years and over	1794
Ownership	
Corporation-owned	2717
Privately owned	5053

TABLE I.—A SUMMARY OF HOUSING CONDITIONS AND OVERCROWDING IN BILSTON

INDUSTRY	BILSTON	ENGLAND AND WALES
	% of Employed population	
Metals	58·3	10·5
Commerce and Finance	11·3	16·5
Personal service and entertainments	6·1	14·5
Public administration and professions	5·8	11·7
Building and utilities	4·6	6·3
Textiles, leather and clothing	4·3	10·8
Transport	2·8	6·9
Mining and quarrying	2·2	5·8
Manufacture of bricks, pottery, glass, chemicals	1·06	2·2
Unclassified industries	3·7	8·3

TABLE II.—INDUSTRIAL STRUCTURE OF BILSTON COMPARED WITH ENGLAND AND WALES (1944)

depths and diameter, some of which have collapsed and many of which are hidden by a layer of earth or soil from a neighbouring shaft. Before this land can be used for building purposes it has to be reclaimed by means of bulldozers and other mechanical equipment, and in order to provide for any future subsidence of the land, any building has to be constructed on concrete rafts.

Briefly, the position in the town at the moment is that it is a heavily industrialised area (see Table II), in which there is no unemployment, but which requires its workers to live in conditions which are not merely depressing, dirty and inconvenient, but which actually constitute a serious menace to the health of the parents and the lives of their children. It was felt by those responsible for the work of rebuilding that something more than new houses and green belts was necessary, and a way of so re-designing the town that it would become a place with a strong community spirit and where the environment would produce the greatest incentive to a man to exploit to the full his personality was sought.

It was at this point that the Council consulted Dr. Neurath and later Sir Charles Reilly.

It is hoped that Bilston, which is practically the birth place of the Industrial Revolution which led to the majority of the evils that populations have to suffer is now to be the first place to benefit from a new type of outlook and planning which attempts to eliminate those evils and to lead to a greater individual development within the community.

A. M. WILLIAMS.

A Town Planner's Solution

IN the two previous articles Mr. Wragge Morley and Mr. Williams have dealt in turn with the theoretical side of social planning and the material problem presented at Bilston. Here I shall discuss the social needs and in some measure the manner in which we are endeavouring to fulfil them.

We are a social race brought up in villages and round village greens, knowing our neighbours, and we inherited from the Greek Agora and the Roman Forum the market place for the exchange of ideas as well as goods. In the seventeenth, eighteenth and nineteenth centuries we developed the square, the crescent and the circus. The Bilston greens are usually oval in shape (but not strictly elliptical, to avoid the necessity of similar and symmetrical houses on either side) and radiate like the petals of a flower from a centre where is placed the Club house. Together they form a communal unit in the town which, like the buildings at Kings College, Cambridge, I propose should be named each after its architect.

To the communal life of the green and the club can be added certain communal domestic advantages. Everyone round the greens, large or small—and it is hoped they will in the end be for people of various incomes—is connected with private telephone wire to the club, which seems reasonable if the club house is to be considered as an extension of the houses providing additional amenities in the way of reading rooms with large open fires, to be used as libraries, billiard rooms, restaurants, dance and debates hall, sometimes to be used as a small theatre.

Such private telephones are now allowed between places of business of the same firm even in different streets and need not cost more than a penny a week added to the rent. Meals could then be ordered either to be sent out to the houses or to be eaten in the club, and relatives and friends spoken to. The sending out of hot meals on a trolley in insulated containers, such as were used in large numbers by hotels and restaurants in Vienna and Budapest before the war, and the calling for the dirty plates afterwards for washing up by machinery in the club house should be a great domestic help in these days and a considerable financial saving.

District heating, that is hot water always on tap together with space heating turned on as required like electricity or gas, are clearly also things to keep the house clean and lighten work.

The nearness of the houses to each other round the greens which makes district heating easier by a shorter run of pipes also makes the mechanical collection of rubbish possible. The suction pipe system used in Paris and in the Quarry Bank block of flats in Leeds, by which garbage and ashes are put down a hopper in the sink and flushed with water through suction pipes to a treatment plant prior to incineration, becomes possible too, and Bilston has been able to get the research engineers of the Hamilton Equipment Company of Birkenhead to work on the problem and reduce the costs of such mechanical collection to that of the present unpleasant insanitary method. On the cost of this new form of refuse collection at Bilston as well as on the cost of district heating the Ministry of Health is granting the same sixty-year loan as on the cost of the houses. In some communities at Bilston the district heating is to be from special boilers, and in others it is hoped to use the waste heat from existing works. With whatever form it takes Bilston will be one of the first towns in England to employ district heating and achieve on a large scale the consequent economies in house-building which follow as well as in house-warming, just as it will be first to abolish the dustman for large areas, a reform which should soon follow everywhere till a sewer for removing rubbish is considered a usual installation. To the chairman of the Health Committee, Dr. Abbott, a great deal of credit is due for pushing through these reforms.

On the other hand the private life of the house and the garden beside and beyond it remains untouched, even though one steps straight out from the front of the house on to the green and the tracks round the green are kept to slow one-way traffic, the slowness of which might be assured by the slight ripple at intervals on the road that is used in some French villages. Motor cars it is suggested should be housed off the greens in a series of lock-up garages with certain public facilities. Children can play in safety and in sight of their mothers on the greens and then toddle off to the Nursery School placed at the far end of the larger greens without crossing a double traffic road.

At Bilston too in some of the further communities it is suggested that there should be a certain number of shops, and in others only a general shop for newspapers and tobacco, etc., in the club house. The High Street of shops, itself a communal institution, must remain and not be detracted from. Between the scattered works at Bilston the large expanses of very broken waste land, described by Mr. Williams in the last article, when levelled by bulldozers and covered with soil and turf brought from the surrounding country, offer ideal large billiard tables of many acres each, if at slightly different levels, on which to build up these semi-enclosed communities. Lewis Mumford, the well-known American sociologist has laid it down that the size of a real neighbourhood unit should not be more than a thousand persons. After that it becomes little more than a geographical expression though a number of smaller communities can well combine together for works and workshops, schools, colleges, theatres and cinemas as towns can for universities and opera houses. At Bilston I have aimed at communities varying from 500 to 1000 persons but as there are walking ways—lovers' walks—between the communities and along the canal banks one has a still larger field in which to find friends and mates though, of course, one will not start by knowing them so well as one knows those on the greens after seeing them enter their houses and then getting to know them at the club.

For the young people of both sexes with the competition at games and debates in music and acting which is bound to develop between the communities to be summed up in the Central Community Centre for the whole town, the ideal of the new town or suburb should follow closely, it seems to me, that of a residential university. The Central Community Centre with its more formal debates, its lectures, its ballet classes and all that goes today to make the best adult education, corresponds roughly to the university buildings, and the smaller clubs each with their sets of greens to the colleges. Just as in the past the young member of parliament got his training in debate at the Unions of Oxford and Cambridge so here he will get it, only more thoroughly, by learning to speak first at his own club at an early age and before the neighbours who really know him. By reading at his club house the books, papers, periodicals of various shades of opinion, instead of the single sheet of his isolationist home as at present, and by discussion and debate he will be better equipped to use his vote when old enough.

SIR CHARLES REILLY.

Far and Near

Calculating Machines Faster than ENIAC

THE U.S. Bureau has announced that calculating machines which will far outdo ENIAC are now under construction. ENIAC was finished late in 1945 at the Moore School of Electrical Engineering of Pennsylvania University (*See* DISCOVERY January 1947, p. 23), and surpassed all previous machines for speed—for instance, the results of ten million different additions and subtractions of ten-digit figures are available within five minutes. It has, however, certain drawbacks, one of which is that about three valves burn out every week and have to be replaced after check-problems have been run through the machine to locate the faulty valve. One of the new machines now being built is EDVAC (Electronic Discrete Variable Calculator) also at Pennsylvania University. It will work about three times as fast as ENIAC on a mere three thousand valves. Another advanced computing machine is being constructed at the Institute of Advanced Studies at Princeton, New Jersey.

The most ambitious calculating machines in prospect in America are, however, those being designed under the guidance of the Bureau of Standards. These will be able to add two ten-digit numbers in a tenth of a thousandth of a second. Its capacity to memorise is to be increased from ENIAC's 200 to 50,000 digits. The machines will receive data at a rate of 1,500 ten-digit numbers a second. The two calculators will be placed in a special 'Computing Laboratory' open to government and private agencies, schools and industry. They will take up the space of a few filing cabinets, whereas ENIAC occupies a room thirty feet wide by fifty feet long. An idea of the difference these machines will make is provided by the following instance. A typical census problem involving the multiplication of 100,000 pairs of five-digit numbers and the summation of their products takes twelve days with machines at present available. The new computers will do the task in ten minutes.

International Congress of Chemistry

SOME 2,000 chemists attended the 11th International Congress of Pure and Applied Chemistry held in London from July 17 to July 24. These International Congresses are normally held every four years, but the last was in Rome in 1938. The only previous one to be held in London was in 1909. (The first was held in Brussels in 1894.) The Congress was opened by its president, Lord Leverhulme. Presidents of the fourteen sections were: Sir John Russell, Sir Henry Dale, Professors Linus Pauling, P. Karrer, T. Tiselius, L. Seekles, Jansen, V. Vesely, Dony-Hénault, L. J. H. Hackspill, J. Piazza; Drs. P. Niggli and H. H. Lowry; and R. Bienaimé.

Making Sea Water Drinkable

THE perfecting of a method for obtaining drinking water from sea water was one of the wartime tasks of the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research, which developed a technique suggested in 1934, depending on the use of the silver compound of base-exchange zeolite. When the zeolite is mixed with sea water, the sodium ions from the salt are taken up by the zeolite and the silver simultaneously set free is precipitated as silver chloride. Silver oxide and barium oxide (or chloride) were mixed with the silver compound, the presence of barium making it possible to remove sulphate ions. The mixture was compressed into briquettes, and so that these would readily break up in sea water bentonite or fuller's earth was incorporated into the briquettes; either of these materials cause disintegration of the briquettes when they absorb water and swell. One briquette desalted over five times its volume of sea water. On pilot-plant scale the Water Pollution Research Laboratory made 7,000 briquettes, involving the manufacture of several hundredweights of silver zeolite. The process was then turned over to the Permutit Company who put into bulk production the desalting apparatus finally used by the R.A.F. (This apparatus which was about the size of a packet of tea, was described in DISCOVERY, 1945, Vol. 6, p. 191).

This was but one of the many wartime problems solved by this laboratory, whose varied activities are described in *Water Pollution Research:* 1939 to 1945, just published by the Stationery Office, price 1*s*. 3*d*.

I.C.I.'s Research Controller

SUCCESSOR to Dr. R. E. Slade as Research Controller of Imperial Chemical Industries is Mr. R. M. Winter. For the past ten years he has worked with Dr. Slade in I.C.I.'s Central Research Department.

BISRA Opens Swansea Laboratories

THE Sketty Hall Laboratories of the British Iron and Steel Federation at Swansea were opened on July 3. The organisation of the Swansea laboratories is the task of the Coatings Committee of the Mechanical Working Division of the Association, one of the six divisions under which BISRA's work is organised. This committee was formed about 14 months ago. Director of the Laboratories is Mr. D. Luther Phillips, formerly in charge of the Siemens Steel Association Research Committee's team of investigators working at Swansea University College. The work of this committee has been taken over by BISRA.

BISRA's Physics Department is now installed in new laboratories at Battersea, and is likely to be in full operation this summer.

Radiochemistry at Durham

THE Londonderry Laboratory of Durham University, the first in the country devoted to radiochemistry, was officially opened on June 4. The director of the laboratory is Professor F. A. Paneth, whose important researches in the radiochemical field gained him an F.R.S. this year.

70,000 Acres of Nature Reserves

A NATIONAL BIOLOGICAL SERVICE to study British wild life and secure its preservation is recommended in the report of the Wild Life Conservation Special Committee which was published last month and which forms a valuable supplement to the Report of the National Parks Committee which appeared a few days earlier.

The committee which produced the first of the two reports mentioned was appointed in August, 1945, to advise the National Parks Committee (England and Wales). Its chairman was first Dr. J. S. Huxley, succeeded in May 1946 by the vice-chairman, Professor A. G. Tansley. The other members of the committee were Lieutenant-Colonel E. N. Buxton, Captain C. Diver, Mr. C. S. Elton, Dr. E. B. Ford, F.R.S., Mr. J. S. L. Gilmour, Mr. E. M. Nicholson, Mr. J. A. Steers, and Professor A. E. Trueman. Main recommendation reached by the committee is that the Government must take general responsibility for conserving the country's flora and fauna.

The report lists a number of areas which should be kept as National Nature Reserves. The total area involved is of the order of 70,000 acres. The list is as follows; classification is into four groups, the approximate acreage of each proposed reserve being given in parenthesis:

Northern Group—Farne Islands, Northumberland (180); Naddle Low Forest, Westmorland (250); North Fen, Esthwaite Water Lancashire (20); Roudsea Wood, Lancashire (650); Hawes Water, Silverdale, Lancashire (20); Colt Park, Yorkshire (150); Askham Bog, York (60); Skipwith Common, Yorkshire (1000) Ainsdale Sand-Dunes, Lancashire (550); Rostherne Mere, Cheshire (330); Alderley Edge, Cheshire (160); Wybunbury Moss, Cheshire (30); Dovedale Ashwood Staffordshire (70).

Western Group—Newborough Dunes and Llandwyin Island, Anglesey (1000); Eglwyseg Mountain, Denbighshire (350); Clarepool Moss, Shropshire (50); Sweat Mere, Shropshire (30); Tregaron Bog, Cardiganshire (2,000); Skomer, Skokholm and Grassholm (830); Worms Head, Glamorgan (100); Kenfig Dunes, Glamorgan (1,500); Avon Gorge, Bristol (400); Cheddar Wood, Somerset (100); Shapwick, Ashcott and Meare Heaths, Somerset (2,500); Braunton Burrows, Devon (2,000); Isles of Scilly (almost 300 acres to be selected).

Southern Group—Morden Bog and Old Decoy Pond, Dorset (650); Heaths from Studland to Arne, Dorset (3,000); Hurst Castle and Keyhaven, Hampshire (900); Matley and Denny Area, New Forest, Hampshire (2,000); Old Winchester Hill, West Meon, Hampshire (450); Kingley Vale, Sussex (650); Basingstoke Canal, two sections, Surrey (600); Box Hill, Surrey (880); High Halstow Marshes, Kent (1,900); Blean Woods, Kent (1,900); Deal Sand-hills, Kent (250); Wye and Crundale Downs, Kent (1,500); Ham Street Woods, Kent (1,000); Birdlip

and Painswick Area, near Gloucester (1,400); Wychwood Forest, Oxfordshire (1,200); Aston Rowant Woods, Oxfordshire (560); Pulpit Hill and Lodge Woods, Buckinghamshire (600 and 90); Tring Reservoirs, Hertfordshire and Buckinghamshire (300); Burnham Beeches, Buckinghamshire (1,000); Windsor Forest, Berkshire (900); Bricket Wood Scrubs, Hertfordshire (300); Water End Swallow Holes, Hertfordshire (50); Wormley Wood, Hertfordshire (500).

Eastern and Central Group—Epping Forest, Essex (almost 3,500); Hales Wood, Essex (80); Horsey Island, Essex (1,900); Shingle Street, Suffolk (1,000); Minsmere Level, Suffolk (2,200); Cavenham Heath, Suffolk (1,280); Lakenheath Warren, Suffolk (2,660); Barton Broad, Norfolk (500); Hickling Broad and Horsey Mere, Norfolk (2,560); Winterton Dunes, Norfolk (430); Blakeney Point, Norfolk (1,100); Scolt Head Island, Norfolk (800); Chippenham Fen and Poor's Fen, Cambridgeshire (200); Wicken Fen, Cambridgeshire (680); Fenland Wildfowl Reserve, Cambridgeshire (1,200 acres. Alternative sites suggested); Monk's Wood and Devill's Wood, Huntingdon (600); Woodwalton Fen, Huntingdon (600); Holme Fen, Huntingdonshire (600); Castor Hanglands, Northamptonshire (1,200); Holywell and Pickworth Woods, Lincolnshire and Rutland (850); Nottingham Sewage Farm (1,000); Creswell Crags, Derbyshire and Nottinghamshire (60); Leighfield Forest, Leicester (620); Wren's Nest, Dudley (120).

The report (Cmd. 7122) is published by the Stationery Office, price four shillings.

LETTER TO THE EDITOR

SIR,

With reference to your article in the June issue, on "Research in Technical Colleges", although the position is aggravated by the present shortage of teachers, even before the war 22 to 24 or more hours actual teaching per week, not including preparation, marking, and organisation, was normal in technical colleges.

Circular 94 of the Ministry pays lip service to the importance and educational value of research but stops short of regarding research as an integral part of the work of the colleges. It is an extra which must remain "compatible with teaching duties".

Furthermore it only envisages facilities being granted to a limited number of individuals who have provided evidence of their capability, for example, by the production of a first research paper. Most teachers are already so out of touch with current literature that to produce a first paper while carrying out the present heavy teaching programme is an impossibility.

Clearly even if Circular 94 is implemented by the Local Education Authorities (and of this there is little evidence), it is likely at most to provide slightly greater facilities for those few who have previously given up their leisure to research; and even for such the reduction to 16 or so teaching hours per week leaves a programme which would be regarded as excessive in a university where 10 hours is a maximum for anyone undertaking research.

Research will only be developed in technical colleges if it is fostered instead of merely being permitted as a luxury, and in the existing conditions men of high qualifications find more attractive opportunities elsewhere. Many are leaving technical teaching for University and industrial appointments and there is a danger of a general deterioration in the quality of technical teachers at a time when the shortage of scientific manpower demands expansion and improvement of technical teaching.

The Percy report, with its suggestions of Higher Colleges of Technology, and Regional Academic Councils, gave rise to the hope that at last the problem was being tackled, but the subsequent developments show a lack of vision. In one area it is suggested that the technical colleges should be deprived of the university work which they are doing, at a time when the Universities cannot expand sufficiently rapidly to meet the demand, and there is a danger that the National Colleges may emerge as glorified trade schools rather than as institutions of university and research level.

At an earlier stage the former junior technical, now technical secondary, schools which have served industry so well in the past are in danger of losing their special character and contacts with industry and the technical colleges by their absorption into multilateral secondary schools.

While the shortage of scientific manpower is recognised as a grave national problem by scientists and industrialists, our educational authorities continue to treat technical education as a sideline of the educational system. The problem will only be solved when technical education is treated as a first priority and its conditions and remuneration made such as to attract a proportion of the most highly qualified technicians from industry to teaching.

I remain,
Yours faithfully,
TECHNICAL TEACHER

South Africa's "CSIR"

THE South African Council for Scientific and Industrial Research set up by the Governor-General on October 5, 1945, has now issued its first annual report. Head of the organisation, which will correspond to Britain's Department of Scientific and Industrial Research, is Professor B. F. J. Schonland. The headquarters of the Council is housed in the South African Mint, Pretoria. A Scientific Liaison Office has been established in London, and the Council has taken over responsibility for the South African Scientific Mission in Washington.

A National Building Research Institute has been started, though it is not yet fully staffed, says the report. It has, however, already begun a project for field research on experimental types of housing in the Cape Peninsula, and is beginning the study of the properties and costs of the various elements of buildings, and the properties of special building materials such as cements and paints, and those containing vermiculite. The senior staff of a National Physical Laboratory have been appointed, and the director and three scientific officers have visited research institutions in Britain to collect information that would guide them in establishing this laboratory. To deal with radio and radar problems a Telecommunications Research Laboratory is being organised, which provides an example of the Council's policy of decentralising its activities whenever practicable, the laboratory being housed in the Department of Electrical Engineering of the University of Witwatersrand.

Plans have been prepared for a National Chemical Research Laboratory. At the moment one unit belonging to this laboratory is studying chemical problems connected with South African fish oils at the University of Capetown. A National Bureau for Personnel Research has been formed, and has started investigating research problems in aptitude testing and industrial psychology.

The Council has taken over the responsibilities of the National Research Council in regard to university bursaries and grants for scientific research.

The Council is fostering the research association system in South Africa, and has already agreed to subsidise the Leather Industries Research Institute at Grahamstown. According to the report negotiations are practically complete for a Fishing Industries Research Association in Cape Town and a Paint Industries Research Association in Durban.

Field Study Centre in Yorkshire

THE Council for the Promotion of Field Studies has accepted an offer by the Worshipful Company of Goldsmiths to provide £6,000 for the establishment of a residential field study and research centre at Malham Tarn House, near Settle, Yorkshire. It is intended that part of it should be used to set up a rock and water garden for plants in their natural setting. Malham Tarn House is situated in a district of great geological, ecological and archaeological interest, and for certain branches of study this field centre will be without parallel in the British Isles. Professor A. G. Tansley has been elected president and the following appointments have been made: *Director and Secretary,*

Mr. F. H. C. Butler; *Warden of Flatford Mill field centre*, Mr. E. A. Ennion; *Warden of Juniper Hall field centre*, Mr. G. E. Hutchings; *Assistant Wardens*, Mr. J. H. Barrett, Mr. E. J. Douglas and Mr. J. H. P. Sankey.

Australian Antarctic Expedition

AN Australian expedition is going to Antarctica next year. In preparation for it a 2,800-mile survey flight has been flown by planes of the Royal Australian Air Force. Preliminary plans include the use of Macquarie Island as a 'half-way house' for the expedition. This island, which rises from the sea more than half-way from the southern coast of Australia to the Antarctic continent, is considered a suitable base for flying boats to support next year's expedition.

New Genetics Journal

THE new genetics journal, *Heredity*, has now appeared, edited by Dr. C. D. Darlington and Professor R. A. Fisher and published by Oliver and Boyd Ltd., the Edinburgh publishers.

The first number contains articles by Dobzhansky, Winge and E. Ditlevsen, D. Lewis, O. H. Frankel, S. C. Harland, L. L. Cavalli and G. Magni, D. S. Falconer and M. E. Wright. Particularly useful items are a survey of genetic research carried out in Britain during the war years and a bibliography of wartime genetic work published in Italy and Germany.

Stark Sentenced by Denazification Court

LAST month Professor Johannes Stark, the German Nobel-prizewinner, was sentenced by a denazification court to four years imprisonment in labour camp and to confiscation of his property. The crimes of which he had been accused were collaboration with the Nazis and publication of anti-Semitic leaflets.

Oxford Expedition to Jan Mayen

THE expedition to Jan Mayen organised by Oxford University Exploration Club sailed last month, and will be away three months. The leader of the expedition is A. J. Marshall, an Australian, of the Department of Zoology at Oxford, who is the only member with previous experience of Arctic research.

The expedition is accompanied by a film unit sent out by Gaumont British Instructional to obtain material for educational films on arctic animal and plant life, and meteorology.

Britain's First Atomic Pile

THE first experimental atomic pile at Harwell will be in operation later this year. This statement was made by the Minister of Supply speaking in the House of Commons on July 24. He said that the work at Harwell was making very good progress, and they hoped to build up there a 'university of nuclear physics' second to none in the world. The adaptation of the Springfields factory to the production of pure uranium from pitchblende was proceeding smoothly, he said, and work was about to begin at Sellafield in West Cumberland on the pile which would carry the process to the next stage. He explained to the House the difference between Harwell and Sellafield; Harwell was a general research establishment, and he stressed that its plant was of an experimental nature of pilot size, whereas the new plant to be erected at Sellafield would be a production unit producing fissile material for use in atomic energy development generally. He would not forecast when Sellafield would be equipped for production, as there was no previous experience of the kind of plant being constructed for it. The Minister was asked whether there was any danger of the operations to be carried out at Sellafield causing some kind of industrial disease among the workers, or affecting the farming and milk production of the locality. He replied that the Medical Research Committee's special committee under Sir Henry Dale, who investigated the whole question of the effect of atomic energy on the health of the local people, considered that there would be no ill effects.

An Atomic Energy Wall-Chart

A USEFUL and effective wall-chart on the subject of Atomic Energy has been published by Pictorial Charts of 3 Harrington Road, London, S.W.7. The price is three shillings.

A Range of Gammexane Preparations

GAMMEXANE, the gamma isomer of benzene hexachloride, was discovered during the war to be a powerful insecticide. In the first instance it was developed as an alternative to derris for use against the turnip flea beetle, but later proved effective against a wide range of insects. About a hundred different kinds of insects successfully killed by Gammexane preparations are listed in the booklet on "The Agrocide Range of Insecticides based on Gammexane for Agricultural and Horticultural Crops" published by Plant Protection Ltd., Novel House, London, S.W.1. Excellent coloured illustrations of eleven susceptible species are included in the booklet, which describes how these insecticides should be used and their compatibility with other insecticidal preparations.

Industrial Gas Turbine Courses

THE National Gas Turbine Establishment is now providing courses dealing with the industrial applications of gas turbines. The first of these courses started at the end of June, and the second is scheduled for the autumn. The syllabus includes turbine theory, workshop processes, blade manufacture and materials. The fee for the course, which lasts a month, is £60; all applications should be made to: Squadron Leader W. R. Thomson, Ladywood Works, Lutterworth.

Night Sky in September

The Moon—New moon occurs on Sept. 14d 19h 28m U.T. and full moon on Sept. 30d 06h 41m. The following conjunctions take place:

September		
10d 11h	Mars in conjunction with the moon.	Mars 3 S.
12d 10h	Saturn	Saturn 4 S.
19d 10h	Jupiter	Jupiter 0.6 N.

The Planets.—Mercury is badly placed for observation and is not observable to the naked eye except at the end of the month when it rises an hour before the sun and may be just glimpsed with difficulty. Venus, in superior conjunction on September 3, is too close to the sun during the month to be seen. Mars, in the constellation of Gemini, can be seen in the morning hours, rising at midnight during the greater portion of the month, and is easily recognised by its ruddy colour. Jupiter can be observed in the constellation of Libra during the early part of the night, setting at 21h, 20h and 19h 20m at the beginning, middle and end of the month, respectively. Its distance from the earth from 517 to 554 million miles. Saturn, in the constellation of Leo, rises at 3h 05m, 2h 20m and 1h 34 m at the beginning, middle and end of the month, respectively, and is easily recognised by its yellowish hue.

Those who have the time and inclination to study variable stars could not do better than keep Algol under observation from time to time. This well-known variable star is in the constellation of Perseus and fluctuates between magnitudes 2 to 4 approximately. The following figures will assist observers when they want to see it at its minimum brightness, mag. 4. It attains its minimum on September 2nd 17h 03m, 5d 13h 52m, 8d 10h 41m, and so on, the interval between the minima being about 2d 20h 50m. The maximum brightness occurs about 3½ hours before and after the minimum and remains practically unaltered for about 2½ days after the star attains its maximum, when it again commences to fade. Owing to its large fluctuations in brightness it is a good star with which to start if practice in observing variables is to be acquired. The variation is caused by a dark body revolving round the brighter one and coming between it and the earth, thus cutting off a lot of its light. In about 7 hours after the edge of the dark body just commences to exclude the light from the earth, the other edge is moving out from the line drawn from the earth to the star, and no more light is intercepted until the dark body has revolved round again and starts to intercept the light—about 2½ days later.

The brightest star in Perseus, Alpha Persei, is easily recognised, and Beta Persei (Algol) can be found by drawing a line through the pole star and Alpha Persei, this line produced passing close to Algol.

Autumnal equinox occurs on September 23rd 21h. Notice that the harvest moon at the end of the month rises nearly at the same time for several nights in succession, 17h 43m, 17h 56m, 18h 08m, on September 28, 29 and 30 respectively in the latitude of Greenwich.

Printed and published in Great Britain by Jarrold & Sons, Ltd., The Empire Press, Norwich.

Mars 3 S.
Saturn 4 S.
upiter 0.6 N.

badly placed
observable to
ne end of the
our before the
sed with diffi-
onjunction on
e to the sun
en. Mars, in
. can be seen
g at midnight
of the month,
by its ruddy
served in the
ing the early
21h, 20h and
, middle and
ectively. Its
m 517 to 554
e constellation
20m and 1h
ddle and end
and is easily
hue.

e and inclina-
could not do
er observation
s well-known
nstellation of
ween magni-
The following
s when they
m brightness,
minimum on
5d 13h 52m,
the interval
about 2d 20h
htness occurs
nd after the
actically un-
after the star
it again com-
its large fluc-
a good star
e in observing
The variation
volving round
ng between it
off a lot of its
r the edge of
ces to exclude
he other edge
e drawn from
no more light
rk body has
arts to inter-
s later.

erseus, Alpha
d, and Beta
d by drawing
r and Alpha
passing close

s on Septem-
the harvest
h rises nearly
ral nights in
om, 18h 08m,
0 respectively